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Recent Developments of Window Materials
*and fabrics for transmitting Ultraviolet Radiation**

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SYNOPSIS:—In this paper the following topics are discussed:
(1) An estimate is obtained of the amount of the short wave-length ultraviolet solar radiation that is shut out by common window glass.
(2) Statistical data are given on the transmissive properties of various newly-developed window glasses and glass substitutes for transmitting the short wave-length ultraviolet solar radiation; also data on the decrease in transmission that these glasses undergo on exposure to the sun and to artificial sources of ultraviolet radiation.
(3) Data are given on the transmission of fabrics, and the reflection of paints, for ultraviolet radiation.

I. Introductory Statement

IT is a generally accepted fact that common window glass shuts out short-wave-length ultraviolet solar rays which prevent rickets[1] and are beneficial for general therapeutic purposes, as for example in the treatment of tuberculous ulcerations, etc. Recent experiments by Russell[2] are of interest in showing that there is a holdover so that a thorough exposure to ultraviolet (at least in chicks) will continue to be effective for a week or two. From this it would appear that it would not be necessary to take sunbaths or baths of artificial light as frequently as was formerly supposed to be required.

In two previous communications[3,4] data were given showing the progress made in the development of glasses and glass substitutes for transmitting the short wave-length ultraviolet solar radiation shut out by ordinary window glass, which rays, as already stated, are found to have a healing value, especially in preventing rickets.[5]

In the earlier communications attention was called to the fact that, on exposure to ultraviolet radiation, all these new glasses and glass substitutes undergo a photochemical change, as a result of which there is a decrease in transmission of radiation in the region of the spectrum (at 290 to 310 $m\mu$) which produces the greatest biological action.

This photochemical change had been called "weathering" (which may include surface deterioration) "aging," "degeneration" (when exposed to artificial sources of ultraviolet radiation) and "solarization," which seems to be the most appropriate designation of the photochemical effect produced in the glass when it is exposed to the sun.

The photochemical effect of exposure of these glasses to the quartz mercury arc may be a little more pronounced than exposure to the sun. However, such an accelerated test seems to be the logical one to apply, and it appears to be coming into common use as a means of determining the performance of a window glass. By this means it is possible to obtain, in a few hours, the information that might require several years of exposure to the sun.

The cause of this decrease in transmission is no doubt owing to the presence of iron, as found in the interesting investigation, recently published by Starkie and Turner,[6] in which it is shown that ferric oxide has a high absorption in the short-wave-length ultraviolet, whereas the presence of ferrous oxide does not appreciably affect the ultraviolet transmission. However, the ultraviolet rays appear to have the property of changing the ferrous iron into the ferric condition. Hence, part of the recent advance made in the production of window glasses that are transparent to short-wave-length ultraviolet radiation is in the use of material that is low in iron content.

II. The Amount of Ultraviolet Solar Radiation Shut Out by Window Glass

Much of the discussion regarding the use of special window glasses for transmitting short-wave-length ultraviolet solar radiation is based upon the observation that common window glass shuts out ultraviolet rays (particularly of wave-lengths less than 310 $m\mu$) which have a well recognized therapeutic value especially in preventing rickets. Hence, in connection with the question of the radiation required for effective dosage, it is desirable to determine the amount of ultraviolet shut out by common window glass.

*A paper presented before the Twenty-third Annual Convention of the Illuminating Engineering Society, Philadelphia, Pa., September 24-27, 1929.

In the complete paper by Coblentz and Stair, now in press, the magnitude of the short-wave-length ultraviolet solar radiation shut out by common window glass is derived by four methods, one of which was mentioned in a previous communication.[4] These values are summarized in table I, from which it may be noticed that the various estimates of the amount of ultraviolet shut out by window glass range from 0.04 per cent to 0.60 per cent of the total amount of incident solar radiation (which ranges from 1.2 to 1.4 gr. cal. per cm² per minute at sea level stations in summer) giving an average value of 0.3 per cent or about 0.004 gr. cal. per cm² per minute.

TABLE I.—SUMMARY OF ESTIMATES OF THE ULTRAVIOLET COMPONENT RADIATION BETWEEN THE WAVE-LENGTHS 295 AND 310 $m\mu$ RELATIVE TO THE TOTAL INCIDENT SOLAR RADIATION OF ALL WAVE-LENGTHS, AT SEA LEVEL AT WASHINGTON, D. C., AIR MASS, $m = 1$.

		%
Method I:	By calculation from the solar spectral energy curve	0.04
Method II:	By using the spectropyrheliometer data of Coblentz and Kahler	0.12
Method III:	By isolating the short-wave-length ultraviolet component by means of a sample of common window glass	0.60
Method IV:	By isolating the ultraviolet part of the solar spectrum by means of a filter of Corning G986A glass, and determining the amount shut out by common window glass	0.40
	Mean	0.3

It should be emphasized that these measurements were made only on the clearest days, which at sea level stations are few in number. Hence the numerical values represent the approximate upper limit that may be expected.

The values obtained by method IV (which appears to be the most reliable), using a filter for isolating the ultraviolet solar radiation, and determining the amount of the short-wave-length ultraviolet shut out by window glass, range from about 0.001 gr. cal. per cm² per min., in winter about 0.007 gr. cal. per cm² per min., in summer (from 600 to 5000 ergs per cm² per sec.). This is in good agreement with the estimate recently published by Dr. Janet Clark[10] who used the rate of blackening of zinc sulphide as a method of measuring ultraviolet radiation, and recorded a variation in intensity of solar radiation between 290 and 310 $m\mu$ which ranged from about 500 ergs in winter to about 4000 ergs per cm² per sec. in summer, in Baltimore. From this it may be seen that rapid progress is being made in establishing the energy relations involved in the biological action of short-wave-length ultraviolet solar radiation.

III. Ultraviolet Transmissive Properties of Window Glasses

Preliminary data on this subject were presented to this society in a progress report by Coblentz and Stair,[4] and the complete paper is now in process of publication in the Bureau of Standards Research Journal.

The observations of Coblentz and Stair have been completely verified by others,[8] in particular by Starkie and Turner,[7] who found (p. 315) that "Quartz-lite had the smallest transmission of the glasses examined, being very little better than ordinary window glass," and, with reference to the general agreement of their results with those obtained by Coblentz and Stair, that (p. 320) "Such agreement may give some general assurance of the methods of measuring transmission adopted by different workers." In this connection it is revelant to add that there is a complete agreement in the measurements made by the various physical and commercial testing laboratories in this country, England and continental Europe, including the laboratories maintained by the manufacturers of these special window glasses.

The importance of using iron-free material is becoming more generally recognized among manufacturers. While this may increase the cost of production, the advantage accrues to the public with but little increase in cost of installing a solarium.

Data on the ultraviolet transmissive properties of the various window glasses now on the market are illustrated in Fig. 1, and summarized in table II, which is self-explanatory; and but little additional comment seems necessary.

As mentioned in previous communications the wave-length 302 $m\mu$ is taken as a standard reference point, beause it lies in the region of great biological activity, and it is easily obtainable as a source of radiometric measurements. In fact, some manufacturers have adopted this wave-length as a convenient reference point for making factory tests of their products.

The number of samples of each kind of glass examined is sufficient to establish an average for different melts. From this it may be seen that glasses are now obtainable which, after chemical stabilization by exposure to ultraviolet radiation, range in transmission from 92 per cent (quartz) to 23 per cent (Vitaglass), at 302 $m\mu$,—(Table II).

TABLE II.—PER CENT TRANSMISSION OF VARIOUS GLASSES AT 302 $m\mu$, WHEN NEW AND AFTER EXPOSURE AT A DISTANCE OF 15 CM. FROM A QUARTZ MERCURY ARC FOR 10 HOURS. BASED ON DATA OBTAINED ON GLASSES EXAMINED PRIOR TO FEB. 1, 1929.

Trade name	Number of samples tested	Average thickness mm.	Average per cent transmission	
			New	After exposure
Quartz glass	1	4.7	92	92
Corex D	15	2.3	61	59
Neuglas	12	2.3	63	49
Uviol-Jena	14	2.3	58	43
Helioglass (Vioray)[1]	24	2.3	58	40
Sunlit	9	2.3	65	39
Vitaglass	19	2.3	48	23
Celo-o-glass[2]	5	.1[3]	30	—
Quartz-lite	16	1.9	0.5	0.5[4]
Common window glass	14	3.3	0.0	0.0

(1) Vioray is the foreign trade-name of Helioglass.
(2) This consists of a fine wire screen whose interstices are covered with cellulose acetate. The value of 30 per cent includes practically all the rays diffusely transmitted.
(3) About 0.1 mm.
(4) About 0.2 per cent for t = 2.3 mm.

The newest glasses on the market are "Corex D," "Neuglas," and "Uviol-Jena." It is interesting to note that while the ultraviolet transmission curves of "Corex D," and "Neuglas" are almost identical when new, there is practically no decrease in transmission in Corex D, on exposure to ultraviolet radiation.

It is to be noted that after complete photochemical seasoning (complete solarization) the transmission of these glasses becomes stabilized and, when not subjected to heat treatment, appears to remain constant. In some of the newest glasses the transmission after solarization is higher than that of the earlier makes of glass before solarization, showing the rapid progress made during the past year in the commercial production of window glasses that are highly transparent to the short-wave-length ultraviolet solar radiation.

While it is interesting and important to learn that the transmission of these glasses becomes stabilized after exposure to the sun and to artificial sources, (which fact is

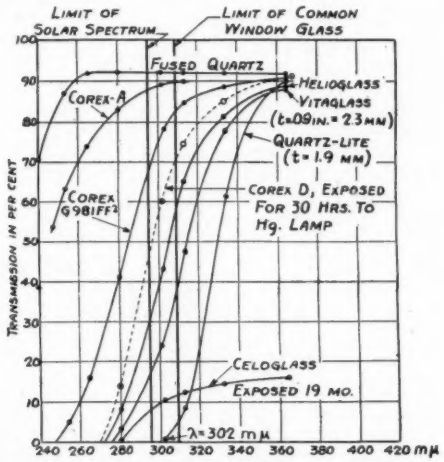

FIG. 1

being widely heralded in the press) this is not the whole story. The crucial question is the total amount that can be transmitted by these glasses after chemical stabilization by solarization—the question of stabilization seems relatively unimportant. From Table II, it may be noted that the majority of these glasses have practically the same transmission (50 to 60 per cent at 302 $m\mu$) when new, but some of them lose almost one-half of their transparency after solarization. Hence the question of real importance is not photochemical stabilization but whether the amount transmitted, after solarization, is sufficient for effective biological use. As pointed out in previous communications,[3,4,11] information is greatly needed regarding the minimum transmission permissible for effective biological results. This will depend on the altitude and latitude of the station. Evidently a glass of high transparency will be required in high latitudes, while in localities where sunshine is abundant a glass having an inferior ultraviolet transmission may prove satisfactory.

The reasonableness of a minimum transmission requirement is evident from the fact that in the examination of common window glasses, for which no claims were made for transmitting short-wave-length ultraviolet solar radiation, we have found samples (from broken windows and selected from glaziers' stock) which, for a standard thickness (say, 0.1" = 2.5 mm) transmitted 0.5 to 1 per cent, even up to 2 per cent at 302 $m\mu$. The average sample of Quartz-lite transmits less than 1 per cent at this wave-length. From this it may be seen that it is possible to produce all gradations in transmission, at 302 $m\mu$, from 1 per cent to 23 per cent (see Table II, Vitaglass) for which glass meager data are available[21] showing an effective biological action which, however, was not 100 per cent curative. In those tests[21] the sample of Vitaglass probably transmitted about 30 per cent, while the sample of Flexo-glass, which was conspicuous in not appreciably preventing rickets, transmitted about 5 per cent, at 302$m\mu$.

In view of this situation, with the great variety of special window glasses now available, this seems to be an appropriate time and place to repeat the suggestion made in previous communications[3,4,11] that, until biological experiments demonstrate that a lower transmission will produce effective results, a fair and reasonable requirement is that the substitute for ordinary window glass after complete photochemical stabilization, shall have a transmission of not less than 25 per cent of the incident radiation at the wave-length 302 $m\mu$.

In this connection it is relevant to cite the work of Tisdall and Brown[19] and of Eddy[5] showing the necessity of using a solarium in order to obtain the direct rays of the sun for effective biological results. The intrinsic intensity of the ultraviolet radiation from the north sky is so low that Dr. Janet Clark[20] has shown that a child, seated in a room at a distance of 16 ft. from a north window, would have to remain there some 15 to 20 hours in order to obtain as much ultraviolet radiation as it would receive in 2 minutes out-of-doors, in sunlight at the noon hour.

In connection with the foregoing discussion of the minimum transmission permissible for effective biological use it is relevant to add that the spectral antirachitic reaction curve, using an equal energy stimulus of different wave-lengths (like the spectral erythemic response curve, with its maximum in the region of 302$m\mu$, observed by Hausser and Vahle) is analagous in principle to the spectral visibility curve of the eye. The "rubescence" curve is the spectral erythemic response multiplied by the spectral energy distribution of the source, and is analagous in principle, to the luminosity curve of the eye.

Using radiation of wave-lengths longer than about 770 $m\mu$, however great the intensity, does not excite vision. Using ultraviolet radiation of wave-lengths greater than 313 $m\mu$, of high intensity and for a prolonged time, does not appear to produce an antirachitic action. Some references appear in which it is thought that wave-lengths longer than 320 $m\mu$ may perhaps have a general therapeutic effect. But this is not proven; and even if this were an established fact, it has no particular significance in favor of the special glasses, because common window glass transmits 5 to 20 per cent at 320 $m\mu$. Hence, if the rays at 320$m\mu$ or longer wave-lengths (which have a relatively high intensity in the solar spectrum) had an important healing value, there would be no need of using special ultraviolet transmitting glass; for common window glass would serve the purpose just as well at a considerable saving in cost. Hence, as already stated, the wave-length 302$m\mu$, which is near the maximum of the biologic (erythemic and perhaps anti-rachitic) response curve, appears to be a suitable reference point for rating these glasses.

The question may be raised as to the meaning of the expression "effective biological action." In the absence of exact information correlating the radiant energy stimulus with the physiological effects produced, especially in preventing or curing rickets, the question of the time of exposure is important. Using artificial sources the time of exposure is measured in minutes. Using sunlight in winter the time of exposure is a matter of hours. For example in recent tests of the clinical value of sunlight through ultraviolet transmitting glass, made on unclothed children, by Caldwell and Dennett (*Jour. Amer. Med. Assn.* 92, p. 2088, 1929) in New York City, the maximum daily exposures ranged from 3 to 5 hours, each child receiving a total of 52 hours' exposure. The conclusions arrived at are (1) that infants and children may be given sunbaths of 2 to 3 hours daily throughout the winter, not as a substitute for ultraviolet lamp irradiation in the cure of disease, but as a preventative measure; and (2) that when the exposures are made in the direct path of the sun's rays, there is sufficient ultraviolet, in the antirachitic range, in the latitude of New York, during the winter, to prevent rickets and spasmophilia in a "normal, properly-fed infant."

The significance of the expression "normal, properly-fed" should not be overlooked. The window glass used transmitted about 45 per cent of the rays at 302 $m\mu$. In other words, if a glass had been used that transmitted 25 per cent at 302 $m\mu$, then it would have been necessary to prolong the exposure for 5 to 7 hours daily, which seems impracticable, with no suggestion of a cure of the disease, but merely as a preventative measure on a properly fed child. This can hardly be considered an "effective biological action," certainly not in obtaining a speedy cure, owing, in this case, to the low intensity of the ultraviolet in sunlight incident on the window. This seems to indicate that the specification of a minimum transmission of 25 per cent at 302 $m\mu$ is too low, and that a value of 45 per cent or 50 per cent would be more nearly in agreement with these physiological findings. It certainly indicates the urgency of obtaining more physiological data on this question.

IV. Ultraviolet Transmission Properties of Fabrics and Reflective Properties of Paints

In a previous communication[3,4,11] data were given on glass substitutes (Flexoglass, Celoglass) for transmitting short-wave-length ultraviolet radiation shut out by common window glass.

During the past year considerable publicity was given to a report that tracing cloth is highly transparent to ultraviolet radiation, thus making it useful for windows. However, tests made by Coblentz and Stair[12] show that the starch used in sizing the fabric is too soluble to make such a combination practicable, and that tracing cloth (whether sized or untreated) is no more transparent to ultraviolet than other fabrics such as nainsook, batiste, or balloon cloth.

Measurements have been made[3,13] on the transmission of ultraviolet and visible radiation through various kinds of material—cotton, natural silk, rayon (artificial silk), linen and wool.

* * *

It was found[13] that feathers have a fairly high transmission to ultraviolet radiation, which is of interest in connection with the problem of irradiating fowls with ultraviolet light.

In considering the ultraviolet reflecting power of paints two factors must be kept in mind, one, the reflecting power of the pigment and, two, the absorptivity of the vehicle.

In a paper by Pfund[14] interesting data are given on the reflecting power of dry pigments. He found that in the spectral region of 290 to 320 $m\mu$ the reflection power of magnesium oxide is over 90 per cent, of basic lead carbonate it is about 50 per cent, of titanium pigment it is still lower and of zinc oxide it is zero per cent.

On the other hand the investigations of Stutz[16] show that linseed oil and nitro-cellulose laquer, used as vehicles, especially after drying, are highly opaque to ultraviolet radiation of wave-lengths shorter than 350 $m\mu$ (see also refs. 14 and 15). Furthermore such vehicles are affected by ultraviolet radiation, especially by the short-wave-length ultraviolet rays in the carbon and the mercury arc. Hence, even though a highly reflecting pigment is used, the reflecting power of a painted surface for ultraviolet radiation of wave-lengths less than 310 $m\mu$ is found to be low, and subject to a further decrease in reflection on exposure to short-wave-length ultraviolet radiation. Hence, if it is desired to produce a surface having a high reflection of ultraviolet radiation, the pigment must be attached by means of an adhesive which is highly transparent to these rays.

Good reflectors of ultraviolet radiation are unlacquered surfaces of metals,—aluminum nickel and chromium.[17] Lacquers deteriorate and decrease in transmission on exposure to ultraviolet radiation.[18] Since this paper has gone to press, a communication by Luckiesh (*Jr. Opt. Soc. Amer.*, 19, p. 1, July, 1929) has been published, giving further data on this subject.

V. References

1. See recent tests by Bethke & Kennard, *Poultry Science*, 6, p. 290, 1927.
2. Russell, Messengale & Howard, *Jour. Biol. Chem.*, 80, p. 155; 1928.
3. Coblentz, TRANS., *Illum. Eng. Soc.*, 23, p. 247; 1928.
4. Coblentz & Stair, TRANS., *Illum. Eng. Soc.*, 23, p. 1121; 1928.
5. Eddy, *Science*, 68, p. XII, Oct. 19, 1928.
6. Starkie and Turner, *Trans. Soc. Glass Tech.*, 12, p. 324; 1928.
7. Starkie and Turner, *Trans. Soc. Glass Tech.*, 12, p. 306; 1928.
8. Goodman and Anderson, *Boston Med. and Surg. Jour.*, 197, p. 1316; 1928.
9. Coblentz and Kahler, *B. S. Sci. Papers No.* 378, 16, p. 233; 1920.
10. Clark, *The Amer. Jour. of Hygiene*, 9, p. 646, May, 1929.
11. Coblentz, *Trans. Nat. Tuberculosis Assocn.*; 1928.
12. *Bur. Standards Tech. News Bull.*, No. 144, p. 30, April 29, 1929.
13. Coblentz, Stair, Schoffstall, *B. S. Research Jour.*, No. 6, 1, p. 105; 1928.
14. Pfund, *Proc. Amer. Soc. Test. Mat.*, 23, Part II, p. 369; 1923.
15. Hallet, *Proc. Amer Soc. Test. Mat.*, 23, Part II, p. 379; 1923.
16. Stutz, *Jour. Franklin Inst.*, 200, p. 87; 1925.
    Jour. Franklin Inst., 202, p. 89; 1926.
17. Coblentz and Stair, *B. S. Jour. of Research*, 2, p. 343; 1929.
18. Coblentz and Kahler, *B. S. Sci. Papers*, No. 342, 15, p. 215; 1919.
19. Tisdall and Brown, *Amer. Jour. Disease of Children*, 34, p. 742; 1927.
20. Clark, *Science*, 68, p. 165, Aug. 17, 1928.
21. Window Glass Substitutes, *Jour. Amer. Medical Assn.*, 88, p. 1562; 1927.

CONTRIBUTIONS on Ultraviolet Ray Transmitting Glass by W. W. Coblenz, Physicist (Radiometry), Bureau of Standards, Washington, D. C., published in past issues of THE GLASS INDUSTRY.

Revised Circular Letter on Ultraviolet Glass. Vol. 9, No. 2, (Feb., 1928) pp. 35-36.

Spectral Characteristics of Light Sources and Window Glass Materials Used in Therapy. Vol. 8, No. 11 (Nov., 1927) pp. 263-267.

Solarization of Ultraviolet Transmitting Glass. Vol. 8, No. 11 (Nov., 1927) p. 267.

Bureau of Standards Circular Letter on Ultraviolet Glass, LC235 (revised). Vol. 8, No. 10 (Oct., 1927) pp. 240-241.

Manufacture and Testing of Ultraviolet Glasses. Vol. 8, No. 10 (Oct., 1927) p. 245.

Also see *"Wanted: A New Glass at a Low Price."* Vol. 7, No. 5 (May, 1926) p. 118.

Ultraviolet Transmitting Glasses. Vol. 8, No. 10 (Oct., 1927) p. 244.

The Composition of Glasses Which Absorb Ultraviolet Rays (from the American Patent Literature). Vol. 7, No. 9 (Sept., 1926) p. 213.

Fused Quartz WINDOW PANES
IN WORLD'S LARGEST SOLARIUM

1. National Vaudeville Artists' sanatorium. Solarium on roof at right.
2. Loading trays with crystal quartz for mak- window panes.
3. Loadnig furnace with trays of crystal quartz.
4. Operating switches for fusing furnace.
5. I. F. Hooper (left) and J. H. Sullivan of General Electric Co., inspecting panes.

Scopes & Feustmann, Archt's.

THE largest solarium in the world using fused quartz windows will be one of the outstanding features of the new sanatorium dedicated September 15 by the National Vaudeville Artists at Saranac Lake, N. Y. In this glassed-in porch built on the roof of the sanatorium high above the trees, where it has unobstructed exposure to the sun's rays during the daylight hours, patients may enjoy healthful sun baths the year round, regardless of outside temperatures. The 1200 fused quartz window panes transmit the ultraviolet rays of the sun better than any other known substance, according to research engineers of the General Electric Company who developed the process and made the quartz windows used in this solarium.

The importance of ultraviolet rays of the sunlight to health and the fact that ordinary window glass cuts out all of these beneficial rays has long been recognized and several years ago Professor Elihu Thomson, director of the General Electric's research laboratory at Lynn, Mass., took up the work of developing a material to replace the window glass which would transmit the health rays. Fused quartz was known as the best medium for the purpose, but to make window panes of it was a problem that required years to solve. The difficulties of making quartz windows can be appreciated when it is realized that the melting point of quartz approaches a temperature of 3200 degrees Fahrenheit, about three times that of glass, and is extremely viscous, or thick, instead of being a mobile liquid. Many methods were investigated and special furnaces were developed before the General Electric Company engineers finally succeeded in making quartz in sheet form, and at a reasonable cost.

One of the first methods developed to produce a high quality quartz window glass consisted in fusing, in a vacuum, specially selected and treated quartz crystals in a square fabricated graphite box, and pressing the fused mass of quartz at 1,000 pounds per square inch while in the molten state. A block of quartz 8 by 5 by 5 inches was thus obtained. This block, when cooled, was sliced into sections ⅛ inch thick and each pane was ground and polished by hand. This method of manufacture was considered too expensive for average use, and further research was carried on to get a satisfactory quartz window that would be sufficiently reasonable in cost so that the benefits of fused quartz could be available for more general use. This additional development work resulted in an entirely new process which cut the cost of manufacture to about one-fifth of previous costs and made it feasible to use quartz in large solariums.

In the present process, quartz crystal, crushed to ¼ inch mesh, is fused in a vacuum on flat graphite discs between thin graphite slabs in the form of a square 7½ by 7½ inches. A number of these trays are stacked in a form and placed in a high temperature furnace. When the quartz is fused, nitrogen gas is admitted to the furnace at a pressure of 150 pounds per square inch to compress the bubbles. The resulting quartz plates, upon cooling, require only squaring of the edges by grinding. The plates themselves are 7½ inches square by ¼ inch thick. This new method does away with cutting, grinding and polishing each pane, and the trays, made at considerable cost, can be used a number of times.

Hygienic Effects of Ultraviolet Radiation in daylight*

by

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SYNOPSIS:—This communication follows an endeavor to find out what benefits can be expected from ultraviolet irradiation, and especially that due to the intensity and region of ultraviolet contained in sunshine. The references here cited were abstracted from the literature and the statements regarding rickets. Made herein are also the results of personal interviews with those familiar with or actually conducting the researches. The work at Cornell University was frequently observed during its progress.

The cure of rickets by radiation has the clear-cut certainty of a chemical experiment and can leave no doubt as to its validity to anyone who has performed or observed such an experiment upon rats, chickens or human infants. In the other diseases mentioned, such as common colds, tuberculosis and pernicious anemia, the effects either are not so clear cut or have been so recently studied that the value of the treatment must be assessed by those having long experience in the field. No attempt is made to describe the high-speed local therapy made possible by certain artificial sources when applied to specialized pathological conditions. The skilled physician experienced with these and other physical therapy devices is familiar with their uses but they carry the potentialities of damage and must be handled by the experienced. Sunshine is so all pervasive, so many people are exposed to it, whether they wish it or not, and its therapeutic usefulness is so great, that an outline of its health significance is not out of place in the transactions of this Society.

When in 1919 and 1920, Huldschinsky[1,2] showed that ultraviolet radiation could cure rickets and in 1921, Dr. Alfred F. Hess[3,4,5] pointed out that rickets in children could be cured by frequent short exposures to the sun's rays and followed this by reports of the seasonal variation of rickets[6] showing that the amount of available natural sunlight was a dominant factor in this malady, the need of an ultraviolet transmitting glass became immediately apparent.

The wave-length of the radiation needed to cure rickets was shown by Dr. Hess to be in the ultraviolet. Direct outdoor sunlight was effective, while sunlight passing through flint glass or ordinary window glass was ineffective.[7] Sunlight reflected from a white surface was beneficial but rather weak. An investigation by the use of glass filters in connection with the quartz mercury[8,9] arc showed a remarkable increase in effectiveness in changing from a filter transmitting but a trace of the .302 μ and .2968 μ mercury lines to a filter which transmitted a substantial portion of these lines. Dr. G. H. Maughan of the Department of Physiology, Cornell University, carried out an exhaustive series of experiments using glass filters with the mercury arc for curing rickets in chickens. The results were first reported in a preliminary way at the Chicago convention of the Illuminating Engineering Society[10] and published in full in the *American Journal of Physiology*.[11]

In the Maughan experiment the assumption was made that the .302 μ line was the effective wave-length and exposures were made so that the product of the exposure time multiplied by the transmission of the glass for the .302 μ line was a constant. The experimental results did not agree with the original assumption but could be explained if the sole effective wave-length was the neighboring line .2968 μ. It does not necessarily follow that with a continous light source, such as sunlight or certain flame carbon arcs, other wave-lengths in this general neighborhood are not also effective, or possibly wave-lengths occurring in gaps between the mercury lines. It is not to be concluded that shorter wave-lengths, such as the .265 μ mercury line effective in the activation of ergosterol, would not be useful for human infants, or animals, such as white rats, but it is certain that with chickens, where the ricket protection seems to come mainly from the light incident upon the legs and combs, the shorter wave-lengths do not contribute appreciably to the effect.

Up to the present there seems to be an apparent discrepancy in the exact wave-lengths useful in the cure of rickets as determined by experiments with sunlight and with the mercury arc. This discrepancy is small and will require critical analysis of present data and further experimental studies before greater exactitude can be attained. The evidence from the Maughan experiment with the quartz mercury arc with different fillers indicates that an overwhelming preponderance of the effect is due to the .2968 μ mercury line. Although Dr. Maughan does not so state, an analysis of his data made by three independent people reveals that within experimental error the entire effect may be attributed to this line alone. Whatever effect the line .302 μ or longer wave-lengths, or the line .2926 μ or shorter may have could not be more than about 2 per cent of that of the .2968 μ line. With sunshine, on the other hand, the energy at .3000 μ is so much greater than at .290 μ a much shaller efficiency of the longer wave-length would be counterbalanced by its greater energy. Moreover, the mercury arc gives no evidence as to the effects of radiation between .2968 μ and .302 μ. Considerable energy between these two points is to be found in sunshine. Fabay[23] shows ratios of energy in noon summer sunshine for the .3022 μ compared to that for .2963 μ of twenty to one. When the sun's altitude is 30 deg. so it traverses twice as much distance through the atmosphere, the ratio calculated from his data becomes 440 to one. The antirachitic effect of sunshine at this altitude although reduced is still present.

Dr. Arthur R. Riddle[27] has taken photographs of the sun's spectrum at different altitudes, *i. e.*, different times of the

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day and year. In his photographs the sun's spectrum apparently terminated at .303 μ in December and .296 μ in June. On cloudly days the limiting wave-lengths are .305 μ and .296 μ. The possibility therefore remains that with a continous source such as sunshine, while the wave-length .302 μ may not be effective, some greater wave-length, say between .302 μ and .313 μ having desirable effects, might again come into play.

Rickets Follows Lack of Sunshine

That the incidence of rickets and the related disease osteomalacia are dependent upon the lack of available sunshine is now becoming recognized. Hess pointed out the seasonal tide of phosphorous in the blood of human infants.[6] Inorganic phosphorous or low calcium content of the blood in growing infants is followed by rickets which can be cured once these elements are restored by having an abundance of these minerals in the diet together with the addition of vitamin D in the form of codliver oil, irradiated ergosterol or by ultraviolet irradiation. Tisdall,[12] experimenting with rats exposed to sunshine for two hours daily at different seasons of the year, found a rather sharp increase in the effectiveness of sunshine between the last of February and the second week of March and between Oct. 24 and Oct. 31. When this sharp increase occurs the sun's noon altitude has increased from 30 to 35 deg. Working during the spring and summer and giving irradiations in the morning and afternoon, terminating and commencing when the sun has reached different altitudes, again shows that 35 deg. is a dividing point in the potency of sunlight.[15,16] A study of health statistics reveals that in those southern cities where the sun never is below 35 deg. in winter, rickets is almost unknown, whereas in northern cities where the winter sun is less than 35 deg. above the horizon at noon, rickets prevails to an increasing extent as one goes northward.

Tisdall's experiments show a protective action of sunlight upon rats even when the sun's altitude is less than 35 deg. but two hours daily exposure to this radiation is not enough.[12] The data on incidence of rickets in northern cities do not show the sunshine to be unable to prevent the malady in human infants if deliberately exposed to what sun there is, but merely that the amount accidentally received is often insufficient.

Kathleen Olga Vaughan[17] reports a striking condition in the Kashmir valley, Northern India. The women of certain of the better classes are by social custom secluded indoors. The *Purdah* women, having the same diet as the men and children, suffer from a peculiar softening of the bones known as *osteomalacia,* due to withdrawal of calcium and phosphorous. Pains often mistaken for rheumatism are felt, the skeleton, especially the pelvis, becomes soft like wax, gradually collapses and the victim becomes a complete cripple. The children go out in the sunlight and rickets is rare among them. The trouble commences among girls when at an age of eight years seclusion is insisted upon. Among the wealthy whose rooms open upon a sunny court and among the poorer classes working out doors this malady does not occur.

Amount of Sunshine Necessary to Cure Rickets

As it is hardly practical to expose babies to sunshine (outdoors) during the winter months, many of the significant experiments have been conducted indoors allowing the sun to shine through windows glazed with ultraviolet transmitting materials. Dr. Edwin T. Wyman[18] working in the special clinic in the out-patient department of the Children's Hospital, Boston, Mass., organized for treating rickets, exposed babies suffering from rickets to winter sunshine transmitted by windows glazed with fused quartz, 3 mm. thick, and two kinds of ultraviolet transmitting glasses with slightly diffusing surfaces here designated as glass *A* and glass *B*. Glass *A* in the thickness used has a transmission of about 80 per cent, and glass *B* perhaps 30 per cent transmission of the .302 μ mercury line. Summary of the results are shown in Table I.

TABLE I—SUMMARY OF RESULTS OF TREATMENT OF HUMAN INFANTS WITH SUNSHINE TRANSMITTED BY DIFFERENT WINDOW MATERIALS FROM WYMAN[18]

Case No.	Color	Sex	Age	Hrs. Sunshine: Dates	Hrs. Min.	Glazed with	Healing
1	C	F	10½	12-17 2-10	136 - 40 Ave. 2 - 20	Quartz	OK
2	W	M	4 mo.	2-11 5-28	110 - 40 Ave. 2 - 24	Quartz	Spasmaphila and severe rickets healed
3	W	M	23	2-15 4-22	110 - 45 Ave. 1 - 40	Glass A	Healed
4	C	F	18 mo.	2-28 4-11 4-12 4-24	84 - 35 Ave. 1 - 58 25 - 40 Ave. 1 - 57	Glass B Glass A	No healing Healing started then cod liver and lamp
5	W	F	5 mo.	4- 9 5- 4 5- 5 5-25	46 - 40 14 - 35	Window glass Quartz	Healing Healing
6	C	M	16 mo.	2-28 4-23	123 hrs.	Glass A	Healing
7	C	M	2 mo.	1-18 4-27	159 - 35	Quartz	Healing
8	W	M	9 mo.	2-10 4-27	91 - 40	Glass A	Healing
9	C	F	22 mo.	1-12 4-11	147 - 50	Glass B	Little evidence of healing

It will be noted in case 1, colored, that the sunshine treatment covered the period from Dec. 17 to Feb. 10 when the sun was lowest. The high transmission through the quartz window gave 90 per cent of the ultraviolet present in the sunshine. The infant was stripped and placed in the spot of sunshine as much as possible which averaged 2 hours, 20 minutes daily. X-ray examination of the wrist bones showed progressive healing definitely noticeable in the published photograph after the third week following a total of 51 hours exposure to sunshine between Dec. 17 and Jan. 9, *i. e.,* when the altitude of the sun is lowest.

The other cases were exposed mainly in the early spring but complete healing was recorded in all cases where high transmission material was used, either quartz or glass *A*. Glass *B* did not benefit rickets in the two very black negro babies, cases 4 and 9. That sunlight in sufficient amount would be beneficial for negroes was evidenced by the case of No. 4 which showed a definite improvement after being transferred to the glass *A* window. Two weeks during which there were 25 hours of sunshine resulted in a definite improvement.

The poor showing of glass *B* is due partly to its lesser ultraviolet transmission, although its spectrogram shows the presence of the .2968 μ line of the mercury arc, and partly to the black skin of the subject. The diffusion due to the cathederal surface was probably not serious as the baby's crib was fairly close to the windows and the diffusion, while sufficient to obscure vision, covers only a small angle.

With ordinary window glass (case 5) no improvement occurred during the time of exposure. Improvement quickly followed its transfer to the quartz window.

Tisdall[12] reports that two hours daily exposure of rats to noon sunshine between 11 and 1 o'cock shows benefit but not cure of rickets in the winter before March 1 but a rapid increase after that date. Cages were exposed to combined sun and skyshine. They were covered with wire mesh and artificially heated with carbon lamps placed below the floor.

The antirachitic effect of skyshine[13] is approximately one-half to two-thirds as much as sunshine and skyshine together—time 11 to 1. The sunshine comparison included both sunny and cloudy days during which on an average not more than one-half of the total time between 11 and 1 had maximum sunshine.

Thus skyshine appears to be capable of curing rickets providing nearly all of the sky hemisphere can be seen from the point of application. The small fraction of the total sky area which is visible through the ordinary window opening, even if no obstruction in the form of window glass is used, was found entirely inadequate to cure rickets.[14] Benefits due to ultraviolet coming through windows can therefore only be expected either when overhead greenhouse construction allows light to enter from a large portion of the sky, and an ultraviolet transparent glass is used; or when sitting in the patch of sunshine coming through an open window or one glazed with an ultraviolet transmitting substance. This was also pointed out by Dr. Janet H. Clark[22] after measuring outdoor ultraviolet, finding the ratio of outdoor to indoor illumination, and calculating therefrom the indoor ultraviolet.

G. F. Heuser and L. C. Norris,[24] working with chickens, attempted to ascertain the minimum dosage of ultraviolet from a quartz mercury arc and from sunshine which would give as good results as when the chicks were fed cod liver oil. The conclusions reached were:

1. An average daily exposure to direct midsummer sunshine at 42.5 deg. N. latitude for 10.9 minutes was sufficient to prevent the development of rickets in chicks and to produce normal growth up to 8 weeks of age. Whether or not an exposure of shorter duration would give equally good results remains yet to be determined.
2. Irradiation from a new Cooper-Hewitt quartz mercury vapor arc, A.C., at a distance of 36 inches and with an equivalent D.C. operating voltage across the arc of 62 volts for a daily average of 9.1 minutes was sufficient to produce normal growth in chicks up to 8 weeks of age but some indications of the development of rickets was obtained. Complete protection was obtained by irradiating for an average of 13.7 minutes daily.
3. The effectiveness upon chicks of irradiation from a quartz mercury vapor arc, A.C., at 36 inches and with an equivalent D.C. voltage of 62 volts was not found to be materially greater, if any, than exposure to strong mid-summer sunshine.
4. The measures used in these experiments gave no positive indication of any difference in the effects from exposure to direct sunshine and irradiation from a quartz mercury vapor arc. However, the results of repeated observations indicated that the chicks in the sunshine group possessed greater vigor and smoother plumage than the chicks in the mercury arc group.

The short exposure time required with midsummer sunshine indicates how unlikely rickets and related diseases are to develop in the summer, but with the lesser available ultraviolet in winter, together with the cold weather increasing the difficulty of getting what sunshine there is, the importance of investigating the curative effects of winter sunshine passing through ultraviolet transmitting glasses resulted in a series of experiments which will be concluded about the time this paper is to be presented.

H. J. Sloan, working under the direction of L. C. Norris and G. F. Heuser, at the Poultry Department, Cornell University, Ithaca, N. Y., is attempting to ascertain the antirachitic value of noon, south exposure, daylight for raising chicks. The exposing pens on the south side of the brooder house are four feet square, and are heated by steam during cold weather. The window frames are tilted 47.5 deg. from the horizontal so the sun's rays are perpendicular at the time of the equinoxes. Each window is covered with approximately 13 square feet of transparent material. Common green window glass was used to glaze one window, and three ultraviolet transmitting materials were used to cover the other twelve windows. Material *A*, slightly diffusing, according to published data of Dr. W. W. Coblentz, transmits 89 per cent of the radiation of the .302 μ line of the mercury arc; material *B*, clear sheets, 55 per cent when new and 37 per cent after a few weeks exposure to sunshine; and material *C*, considerably diffusing, transmits about 30 per cent. The chicks were so close to the window that diffusion should cause but little loss in effectiveness.

Chickens fed on a normal diet will develop rickets unless given some antirachitic factor such as cod liver oil or ultraviolet radiation. Some other animals such as white rats develop rickets only if fed a diet deficient in either calcium or phosphorous. The chicks in this experiment were fed a special uniform diet which had sufficient but not overabundant mineral content. The first experiment covered exposures of from one-half to four hours daily under each of the four kinds of windows. The season of year was from Dec. 22, 1927, to March 15, 1928, *i. e.*, the twelve weeks following the shortest days. The exposures were made each day regardless of weather and included sunshine and cloud for a period centering at noon. Except in the case of window glass there was apparently good protection against rickets with material *A*, one-half hour daily exposure; material *B*, 1 hour; material *C*, 2 hours. Common window glass with 4 hours daily exposure did not, however, afford protection from rickets.

The second period of twelve weeks immediately following the spring equinox, March 22 to June 14, 1928, showed complete protection against rickets with material *A*, 10 minutes daily; *B*, 20 minutes daily; *C*, 40 minutes daily; and great protection, nearly but not quite complete, with half the above time; *i. e.*, *A*, 5 minutes; *B*, 10 minutes; *C*, 20 minutes, Window glass, 40 minutes daily, was almost as bad as those kept away from sunlight.

The third period, June 21 to Sept. 13, 1928, after reorgan-

izing the plan and slightly improving the diet, gave complete protection with material *A* in 5 minutes, *B* in 10 minutes, *C* in 10 minutes, while those exposed under window glass 20 minutes daily were practically the same as those kept away from the light.

These first three experiments demonstrated how small was the amount of ultraviolet required for the health of the chicks, as well as the absolute necessity for the little which was required.

The fourth experiment, 6 weeks before to 6 weeks after the winter solstice, Nov. 11, 1928, to Feb. 1, 1929, was again revised as to diet, and the exposure periods shortened so as to show significant differences. Almost complete protection was afforded by material *A* in 40 minutes exposure; material *B* and *C* showed partial protection only in this length of time. Window glass protection is nil.

The fifth experiment, 6 weeks before to 6 weeks after the spring equinox, Feb. 7 to May 2, shows complete protection with material *A* in 20 minutes, and partial protection in the same time with materials *B* and *C*. These results clearly demonstrate the advantage of using as highly transparent a window as possible if the time of exposure must be limited, yet if all-day exposure is feasible, the window material with but partial transmission may produce all the result that may be desired. Other unfavorable conditions, such as unsuitable direction of exposure of windows, might dictate the choice of a glazing material of highest transparency.

It is hoped that the full account of this work will be published shortly. Until then this brief outline of the results will have to suffice.

The amount of sunshine needed to prevent or cure rickets is less than is necessary to cause sunburn and tanning. When sun or other ultraviolet treatments are raised to a level giving an erythema, a tan or pigmentation follows, protecting the body against further overdosage. Aside from its discomfort this also increases the necessary time for subsequent irradiations. If the irradiations can be kept just below the level causing tanning the most beneficial effects for treatment of rickets seems to ensue.

The therapeutic effect of sunshine most fully described at the present time is that of controlling the calcium and phosphorous metabolism. Not only is this probably the most important from the standpoint of human welfare, but it is the mechanism most accurately determinable from biological studies of rickets. Other important health factors of sunshine must also be considered although the results are not as clear cut. Several different mechanisms due to radiation occur simultaneously.

The penetrating radiation in the red and near infra-red constitutes a considerable portion of the total radiant energy of sunshine as received at the earth's surface. This seems to heat the deeper tissues of the body and is capable of producing changes of circulation, beneficial for aches and pains, sprains, bruises, etc., but too much of it may overheat the brain and spinal cord producing sunstroke. The calcium metabolism effect is caused by the extreme short-wave-length end of the sun's spectrum after penetrating the earth's atmosphere. The mechanism causing the erythema of sunburn and subsequent tanning appears to be excited by much the same region in the ultraviolet.

Colds

Acute respiratory infections, such as common colds are less frequent in summer than winter. The greater amount of sunshine in summer than in winter has been attributed as the cause of this seasonal change. In order to verify the reasonableness of this explanation Dr. Geo. H. Maughan and Dr. D. F. Smiley[20,21] studied the effect of artificial ultraviolet irradiation on a group of 23 students selected from 81 male university students known to be very susceptible to colds. The remaining 58 students were observed as a check. Group 1 was irradiated each week for 5 minutes over the entire anterior skin surfaces, the eyes only being protected, and 5 minutes over the entire posterior surfaces. The ultraviolet source was a quartz mercury arc suspended 30 inches over the table on which the treatments were administered. The results of this study are shown in Table II.

The exposures given in the next set of cases were varied according to the individual from 5 to 8 minutes on each side and was such that no erythema or sunburn or tanning resulted.

TABLE II—COLDS AS AFFECTED BY ULTRAVIOLET IRRADIATION FROM MAUGHAN AND SMILEY[21]

	Group 1 Irradiated	Group 2 Control
Number of persons	23	58
Colds during period of treatment:		
Mild	26	93
Severe	8	51
Total	34	144
Number per person	1.48	2.48
Apparent per cent reduction	40.3	

First period—Week ending Nov. 10 through week ending Jan. 25, 1928

	Group 1 Irradiated	Group 2 Control
Number of persons	23	26
Colds during period of treatment:		
Mild	23	44
Severe	13	29
Total	36	73
Number per person	1.56	2.80
Apparent per cent reduction	44.2	

Second period—Week ending Feb. 1 through week ending Mar. 29, 1928.

	Group 1 Irradiated	Group 2 Control
Number of persons	21	24
Colds during period of treatment:		
Mild	14	42
Severe	12	25
Total	26	67
Number per person	1.24	2.79
Apparent per cent reduction	55.5	

Warnings of the dangers liable to be encountered in the indiscriminate use of all types of radiation therapy usually accompanied articles describing such treatment. If such a warning were to accompany this statement on heliotherapy it would advise not to get sunstroke and not to stay out on the bathing beach too long the first day and get an overpowering dose of sunburn. Either condition is uncomfortable, dangerous and sometimes fatal. Sunshine treatment is, however, usually indulged in without resort to the advice of a physician, and the popular assumption, probably incorrect, is that the average run of humanity knows how much sunshine is good for it.

Ultraviolet treatment with any source is assumed to be

harmful in certain conditions, and according to the information available an overdose causing erythema or sunburn of a considerable area of the skin is to be avoided in diseases of the kidney,[26] diabetes, low blood pressure,[25] high blood pressure, artereosclerosis,[26] decompensated heart lesions,[26] high fever,[26] toxemia.[26]

Pulmonary tuberculosis is so often unfavorably affected by injudicious light treatment such as overheating from radiant energy or an aggravation of fever by too much erythema that the experienced sanatarium physician, must be relied upon to prescribe individual treatment which will give the benefits to be derived by sufferers from this most treacherous disease.

It is, however, generally conceded that all other forms of tuberculosis, grouped under the general term of surgical tuberculosis, can be cured or greatly improved by judicious ultraviolet therapy whether by artificial sources or by the sun. Tuberculosis of the skin (Lupus); peritoneum, glands, bones and joints have all yielded to ultraviolet treatment. Sinouses, or running sores, sometimes following surgical operations, when of tubercular cause, can often be healed by ultraviolet treatment.

In pernicious anemia, according to Macht, there is a specific toxin present in the blood stream. Normal blood serum has slight inhibitory effect upon the growth of the roots of bean seedlings (Lupus Albus) but the blood serum of pernicious anemia patients has a much greater inhibitory effect. Blood serum of pernicious anemia patients exposed in quartz tubes to ultraviolet radiation loses its inhibiting effect, the per cent detoxification depending upon the product of time and intensity of ultraviolet irradiation. This substance, which is a toxin to the bean seedlings, and is presumably also the toxin causing the pernicious anemia, can be destroyed by ultraviolet of wave-lengths between .2535 μ and .405 μ, the .313 μ line being the most effective for equal energy. Several times the effectiveness is secured by an addition of chemically pure eosin.

Dr. Macht reports 24 cases of pernicious anemia in which the condition was improved by ultraviolet therapy after injecting pure eosin into the blood stream. In some cases the ultraviolet was used alone, in some cases the liver treatment was also used. If the liver treatment had been commenced before the light treatment, it was continued in the same dosage, but when the light was used in addition, the results were much more favorable than with the liver treatment alone. In the cases which were tested with the bean sprouts, the toxin present before was absent after the treatment and the blood serum reacted normally. The conclusion is reached that the pernicious anemia toxin is destroyed and the patient gets well as soon as the hemoglobin builds up sufficiently. Recurrences have not yet been reported although none of the cases have been observed long enough to be sure whether a single course of light treatment will cause permanent cure.

From the above it would appear that the ultraviolet useful in pernicious anemia is by no means as restricted in range as that required for the cure of rickets and that only about half of the useful region is removed by ordinary window glass, so there might be distinct benefit by sitting in the ordinary glassed-in "sun parlor" if the patient were to actually expose sufficient skin area to the rays of the sun shining through the glass.

Summary

Investigations have not as yet covered all of the possible influences of sunlight on health. Benefits from general exposure to sunshine which have already been fairly definitely demonstrated are:

(1) In infants and growing children, promotion of the growth of bone and teeth, prevention of rickets.
(2) In nursing and pregnant mothers, increased calcium assimilation, preventing destruction of teeth, and injury to bones. Adequate supply of calcium to the infant for growth of bones and formation of baby teeth.
(3) Lessened danger of spasms due to lack of calcium in the blood.
(4) Reduction in number and severity of colds.

Benefits which may be hoped for when exposure to sunshine is carried out under the direction of an experienced physician are:

(1) Great improvement or cure of all forms extra-pulmonary tuberculosis.
(2) Improvement in some cases of pulmonary tuberculosis.
(3) Possible advantage in cases of pernicious anemia.

Bibliography

[1] Huldschinsky, K., *Deutsch Wchnschr.*, 1919, XIV, 712.

[2] Huldschinsky, K., *Zeitschrift f. Orthop Chir.*, 1920, XXXIX (or LXXXIX?), 426.

[3] Hess, Dr. Alfred F. and Unger, L. J., *Proceedings Experimental Biology and Medicine*, 1921, XVIII, 298.

[4] Hess and Unger, *Journal American Medical Association*, 1921, LXXVII.

[5] Hess and Unger, *American Journal of the Diseases of Children*, 1921, XXII, 186.

[6] Hess, A. F. and Lundagen, Marion A., *Proceedings of the Society for Experimental Biology and Medicine*, 1922, XIX, pp. 380-382. Also *J. American Medical Association*, Vol. 79, p. 2210, Dec. 30, 1922.

[7] Hess, A. F., Unger, L. J., Pappenheimer, A. M., 104 (1851), p. 238, *Scientific Proceedings* (121).

[8] Study of Light Waves in Their Relation to Their Protective Action on Rickets, Alfred F. Hess, A. M. Pappenheimer and Mildred Weinstock, *Proceedings of the Society for Experimental Medicine and Biology*, 1922, XX, p. 14.

[9] Same title, *Journal American Medical Association*, Vol. 80, pp. 687-690, March 10, 1923.

[10] Maughan, Communicated discussion introduced by H. P. Gage, TRANSACTIONS *Illuminating Engineering Society*, Vol. 23, XXIII, p. 241, March, 1928.

[11] Ultraviolet Wave-Lengths Valuable in the Cure of Rickets in Chickens, George H. Maughan, *American Journal of Physiology*, Vol. 87, p. 381, Dec., 1928.

[12] Tisdall, Frederick F., and Brown, Alan., *American Journal of Diseases of Children*, Vol. 34, Nov., 1927, p. 721.

[13] Same, page 737.

[14] Same, page 742.

[15] The Relation of the Altitude of the Sun to its Antirachitic Effect. Tisdall, F. F. and Brown, A., *The Canadian Medical Association Journal*, 1929, XX, p. 253.

[16] Same, *Journal American Medical Association*.

[17] Vaughan, Kathleen Olga. Light Deficiency as the Principal Cause of Osteamalacia in India, *British Journal of Actmotherapy*, Vol. III, p. 243, March, 1929.

[18] Wyman, Edwin T., The Prevention and Treatment of Rickets, *Boston Medical and Surgical Journal*, Vol. 197, pp. 376-388, Sept. 8, 1927.

[19] Macht, David I. and Anderson, William T., Jr., *Journal Pharmacology and Experimental Therapeutics*, Vol. XXXIV, p. 365, Dec., 1928.

[20] Maughan, G. H. and Smiley, D. F., The Effect of General Irradiation with Ultraviolet Light Upon the Frequency of Colds, *Journal Prev. Med.*, Vol. 2, Jan., 1928.

[21] Maughan, G. H. and Smiley, D. F., Irradiations from a Quartz-Mercury-Vapor Lamp as a Factor in the Control of Common Colds, *American Journal of Hygiene*, Vol. IX, p. 466, March, 1929.

[22] Clark, Janet H., The Probable Amount of Ultraviolet Radiation Obtained Indoors, *Science*, Vol. LXVIII, p. 165, Aug. 17, 1928.

[23] Fabry, Charles and Buisson, H., A Study of the Ultraviolet End of the Solar Spectrum, *Astrophysical Journal*, Vol. LIV, p. 297, Dec., 1921.

[24] Heuser, G. F. and Norris, L. C., Rickets in Chicks, *Poultry Science*, Vol. VIII, p. 89, Dec.-Jan., 1928-29.

[25] Laurens, Henry, Some of the Physiological Effects of Radiant Energy, *Journal Optical Society and R. S. I.*, Vol. 18, p. 237, March, 1929.

[26] Ehrlich, R. L., Observations of Resident Staff, Koch Hospital, Koch, Mo., *Journal Missouri State Medical Association*, pp. 177-9, April, 1929.

[27] Riddle, Arthur R., The Short Wave-Length Limit in Solar Radiation as a Function of the Time of Year and Time of Day, *Journal Optical Society and R. S. I.*, Vol. 18, p. 442, June, 1929.

The Manufacture of Wire Glass

as exemplified by patented inventions

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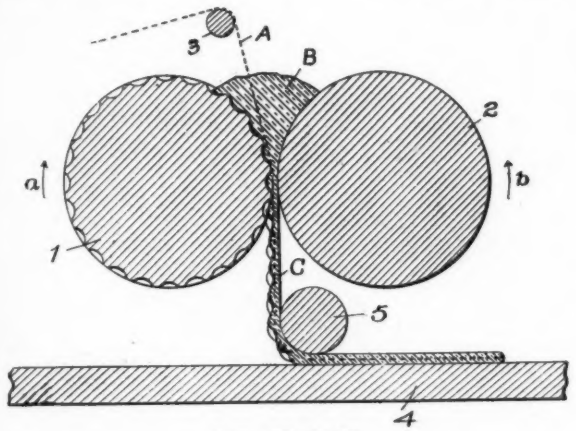
(*Continued from the September Issue*)

49. Franzen, 844,587, February 19, 1907.

The method consists in introducing the wire progressively through the batch of molten glass as the latter is being spread by the forming-rolls and introducing it free from contact with any forming-surface until it passes between



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the rolls, where it comes into contact with the roll which is pitted. The sheet of glass which is produced by the forming-rolls will then contain the wire embedded in its body, and its surface will bear protuberances of unchilled glass left by the pits in the pitted forming-roll. These excrescences or protuberances are reduced to produce a level and polished surface in any preferred manner, such as by receiving the sheet upon a table and compressing it beneath a roll.

52. Carter and Beebe, 849,459, April 9, 1907.

The method of this patent consists in pouring a batch of molten glass upon a table in front of a roll, placing a wire trellis behind the roll and in front of a scraper, pouring a second batch of glass on the end of the trellis and by advancing the roll and scraper, rolling the first batch into a sheet and scraping the second batch into a sheet upon the first sheet with the trellis embedded between the sheets.

53. Walsh, 851,787, April 30, 1907.

The method consists in forming a single mass of molten glass into a sheet, progressively folding the sheet longitudinally of its length to produce two independent layers, arranging a piece of wire mesh between the layers and thereafter pressing the layers together.

54. Shuman, A., 856,661, June 11, 1907.

The method of making wire glass consists in rolling a mass of molten glass into a sheet and simultaneously therewith feeding into the advancing end of the glass a wire meshed sheet whereby it is enveloped in the mass of the glass and intermediate of the two surfaces thereof during the rolling operation, and simultaneously therewith electro magnetically suspending the wire meshed sheet immediately at the place where it entered the mass of molten glass, whereby the meshed wire sheet is suspended and guided to the mass of molten glass at the desired distance below the lower surface.

55. McLane, 861,879, July 30, 1907.

The process consists in forming two sheets from molten glass, reheating the exposed surfaces of both sheets to a welding temperature, applying a wire netting to one of the sheets, bringing the reheated surfaces of the sheets into contact and pressing them together.

56. McLane, 862,096, July 30, 1907.

The process of making wire glass consists in rolling a sheet or layer of glass, remelting the exposed surface thereof, applying a wire netting thereto, and simultaneously applying heat to the wire and the exposed surface of the sheet, and applying another sheet onto the first sheet.

57. Jungers, 867,510, October 1, 1907.

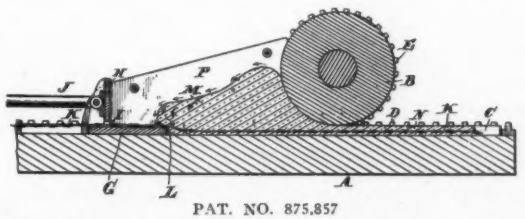
The process consists in concurrently forming upon a substantially horizontal support two layers of glass, one upon the other and formed in successive order, and simultaneously paying out under tension and positively and continuously directing into the relatively progressing line of juncture between the finished upper surface of the first layer and advance meeting portion of the second layer, a wire reinforcement.

58. Shuman, A., 868,713, October 22, 1907.

The method consists in rolling down a mass of molten glass into a sheet and feeding into the upper surface of a wire netting and supporting wire netting away from the roller at a point close to where the netting enters it and gradually lowering the support for the wire netting as the mass of molten glass becomes reduced and at the same time advancing the support forward in a horizontal direction with speed equal to the roller.

59. Shuman, F., 875,857, January 7, 1908.

The process for making wire glass consists in rolling down a mass of glass into a sheet and during the operation



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feeding into the forward part of the mass of glass near its bottom a meshed wire layer, supporting the meshed wire layer slightly above the support upon which the glass is

rolled so that the molten glass may flow to the under side through the meshes, and advancing the place of support of the meshed wire layer as the rolling operation proceeds but at a gradually decreasing speed relatively to the speed of the rolling operation.

60. Baldwin, 880,772, March 3, 1908.

This method of making wire glass, consists in forming a sheet of glass with a wire fabric one surface thereof, progressively subjecting all portions of the sheet equally to pressure, to force a portion of the glass through the meshes of the fabric, and simultaneously forming the portion of glass into a smooth uniform layer on the fabric.

61. Shuman, A., 889,978, June 9, 1908.

A sheet of wire glass having a metal center formed of an open hexagonal mesh combined with a series of parallel straight wires united to the wires forming the hexagonal mesh and dividing said hexagonal meshes for supporting the weight of the glass when held vertically at the top.

62. Speer and Taylor, 906,952, December 15, 1908.

The method consists in spreading in one direction on a bed a layer of glass, spreading another layer of glass in the opposite direction on the first layer, and simultaneously with the forming of the second layer interposing a metallic netting between the two layers.

63. Quertinmont, 911,678, February 9, 1909.

The method of making plate, window or sheet wire glass comprises supporting of wire netting between the bottom and top planes of a shallow mold introducing molten glass into the mold and permitting the upper surface of the molten glass to freely and uniformly overflow the upper surface corresponds to the plane of the top edges of the frame and completely drain off the superfluous molten glass and then cool the body of glass in the mold.

64. Gibert, 912,950, February 16, 1909.

Wired glass comprising two sets of crossed wires and a third set of cross tie wires interlaced therewith at points remote from the points of intersection, the first mentioned sets to form a mesh of only two wire thickness at all points of intersection and to evenly distribute the supporting strength of the mesh, in combination with glass in which the mess is embedded.

65. Arbogast, 916,250, March 23, 1909.

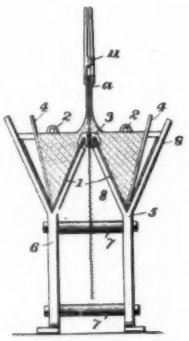
The method of producing wire glass articles consists in assembling two layers of glass of the required size and shape to form the article to be produced, with an interposed layer of wire mesh; placing the layers of glass and wire mesh upon a former; and then subjecting the layers to heat within a furnace to cause them to amalgamate, and during amalgamation to assume the shape of the former.

66. Quertinmont, 936,663, October 12, 1909.

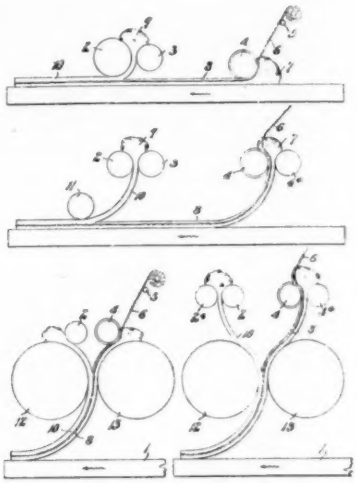
The method of making plate, window or sheet glass of double thickness comprises the introduction of molten glass into two molds so as to freely overflow the upper inner edge of each mold until its upper surface corresponds to the plane of the top edge of each mold and carefully draining off the superfluous molten glass in each mold and bringing the exposed surfaces of the bodies of glass in the molds into intimate contact while they are still in a plastic condition.

67. Quertinmont, 936,665, October 12, 1909.

The process comprises passing a reinforcing element alongside molten masses and positively piling up the molten masses at the plane of formation whereby layers from the mass are simultaneously forced toward and freely on both sides of the reinforcing element.



PAT. NO. 936,665



PAT. NO. 940,837

68. Jungers, 938,385, October 26, 1909.

A single-pour process of making wire glass, which consists in rolling out a full-thickness sheet of glass and progressively and simultaneously embedding a sheet of wire netting therein, by forcing the wire into and below the surface of the sheet to a uniform depth by the use of means forming cuts narrow relatively to their depth and having smooth, dense surfaces, practically non-absorbent and free from occluded gas, whereby the insetting is accomplished without contamination of the glass.

69. Walsh, 940,835, November 23, 1909.

The method of making wire glass, consists in rolling a mass of molten glass into two independent layers, arranging a piece of wire mesh or fabric upon each of the layers, and thereafter covering the wire fabric with a coating of glass.

70. Walsh, 940,836, November 23, 1909.

The method consists in forming a complete sheet of wire glass and finishing the sheet by welding a layer of glass underneath the surface of the sheet.

71. Walsh, 940,837, November 23, 1909.

The invention contemplates the method of forming a sheet of glass having wire mesh buried therein and thereafter forming a second sheet or layer of glass and welding it to the uneven surface of the sheet in which the wire mesh is embedded. Preferably the wire mesh is embedded in the upper surface of the first formed sheet or layer at the time that the sheet is being made so that in its heated condition the wire mesh will not be exposed to atmosphere and will accordingly preserve its bright and new appearance in the glass.

72. Walsh, 940,838, November 23, 1909.

The method consists in forming a mass of molten glass into a layer, forcing a wire mesh into the underneath surface of the layer so that it is completely covered, forming a

separate mass of molten glass into a layer and combining the layers together.

73. Walsh, 940,839, November 23, 1909.

The method consists in forming a mass of molten glass into a layer and drawing a wire mesh beneath one surface thereof so that it is completely covered, and thereafter covering that surface of the layer with a mass of molten glass to produce a finished sheet.

74. Walsh, 940,841, November 23, 1909.

The method consists in forming a sheet or layer of glass, drawing a wire mesh into the sheet so that it is completely covered, and thereafter forming a second sheet of layer of glass, and welding it to that surface of the first-formed sheet or layer into which the wire mesh was drawn.

75. Walsh, 940,842, November 23, 1909.

The method of making wire glass consists in progressively forming masses of molten glass into independent layers or sheets and simultaneously exerting tension on a wire mesh so that it will cut its way into the underneath face of the top layer, and thereafter combining the layers together to form a single sheet of wire glass.

76. Walsh, 940,843, November 23, 1909.

This method consists in forming a sheet of glass from one pour, progressively arranging a piece of wire mesh on the top face of the sheet and then superimposing thereon a plurality of layers from another pour.

77. Walsh, 940,845, November 23, 1909.

The method consists in forming a layer of glass dumping a batch of molten glass onto the layer, dividing into two portions and rolling them into separate superimposed layers, and arranging a wire mesh between two of the layers.

78. Walsh, 940,846, November 23, 1909.

The method consists in forming a single batch or mass of molten glass into three superimposed layers and arranging a wire mesh between the bottom layer and the second layer.

79. Franzen, 945,314, January 4, 1910.

The invention consists in spreading upon the newly formed and still hot surface of the otherwise completed sheet of wire-glass a finishing layer or coating of glass which will enter and fill the surface irregularities produced by the movement of the wire and give the desired smoothness of surface to the whole.

80. Franzen, 945,315, January 4, 1910.

The method of making wire glass consists in supporting a length of wire netting in horizontal position from end to end in close proximity to the plane of formation of a layer of glass, spreading a batch of molten glass to layer form and advancing it as it is formed beneath the length of netting, thereby heating the length of netting to or approximately to the temperature of the glass, releasing one end of the length of netting, allowing it to fall and rest upon the surface of the layer, teeming a second batch of glass upon that portion of the initial layer to which the netting has been so applied and spreading such second batch of glass to layer form over the initial layer and netting, exerting a pull on the entire length of netting at the beginning of the second spreading operation to remove the slack due to expansion and maintaining such tension during the spreading of such layer.

81. Franzen, 945,318, January 4, 1910.

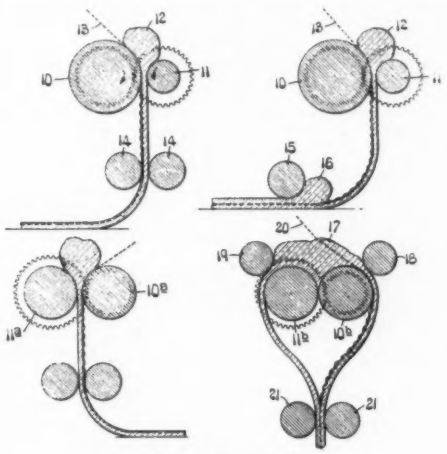
The method consists in spreading an initial layer of glass, maintaining a web of wire in horizontal position and when the initial layer is completed letting the horizontally maintained web fall free by gravity and lie prone upon the surface of the initial layer, and by means of a roller spreading a second layer of glass upon the initial layer with the wire so applied to it.

82. Guyaux, Sr., Guyaux, Jr., and F. Guyaux, 954,956, April 12, 1910.

The method of making wire glass comprises forming a sheet of soft glass, horizontally supporting a sheet of wire mesh, dropping the soft sheet glass on top of the wire mesh, passing a portion of the sheet of glass through the wire mesh and then pressing the soft glass sheet and wire mesh into wire glass.

83. Baldwin, 959,102, May 24, 1910.

The method of making wire glass consists in rolling molten glass into sheet form, introducing a wire mesh and



PAT. NO. 959,102

simultaneously displacing the surface glass on one side of sheet in a longitudinal direction onto the wire mesh.

85. Arbogast, 960,146, May 31, 1910.

The method consists in blowing a gathering of glass within a mold to provide the outer shell or thickness of the vessel, then fitting a wire mesh basket within the blown shell, and finally blowing another gathering of glass within the wire mesh to form the inner shell or surface of the vessel.

86. Franzen, 966,819, August 9, 1910.

The method consists in first spreading a batch of hot glass to a layer of curved form, then spreading another batch of hot glass to layer form against one surface of the initial layer, and at the same time with the spreading of the second batch of glass introducing between the two bodies of glass a taut-drawn web of wire netting in a plane tangential to the curve of the initial layer at the point of union and bending the whole into reverse curvature, and finally flattening the completed sheet.

(To be continued)

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The Rationalization of Industry

THEORIZING about the rationalization of industry has long been a favorite pastime of many industrialists. Just what does industrial rationalization mean? A satisfactory definition is hard to find.

In the glass manufacturing industry there are a number of outstanding concerns which have so organized, financed and systematized their operations, so thoroughly eliminated waste and in general so efficiently conducted their affairs that they have been able to keep production costs far below the average, while still maintaining a liberal wage scale and increasing the dividends to stockowners. Such concerns, presumably, may be said to be truly rationalized. When all of the industry's manufacturers reach a similar comfortable position, the trade will be enjoying national rationalization.

One definition of national rationalization, said to have come from Germany, the originator, it is claimed, of the modern idea of industrial rationalization, sets forth that the practice of rationalization involves the employment of the technical, commercial and financial organization of an industry in such a manner that the cost of manufacture of the products of the industry can be reduced to the lowest possible level without adversely affecting the conditions of employment of those in the industry; and requires the employment of all methods of technique and organization in order to increase the productivity of the workers to the highest possible degree and as a result improve, increase and cheapen production.

With this definition as a guide it is affirmed, the following steps might logically be taken toward establishing national industry on a rational basis:

Standardization of products and processes; provision for research and development; concentration of production; purchase and sales arrangements; financial plans; labor policy; general policy and control.

Needs of the Theatres for Glass

In a paper "Theatre Lighting—Its Tragedies, Its Virtues" presented before the 23rd annual meeting of the Illuminating Engineering Society at Philadelphia, September 24-27, 1929 the authors, Frank Cambria, director of art and stagecraft, and Francis M. Falge, lighting specialist of the Publix Theatres Corporation discussed colored glass for producing desired lighting effects in playhouses. Excerpts from their paper follow:

Gelatin color media have, in the past, been the most satisfactory producers of color, especially because of the very wide range af attractive colors that were available. With higher wattages and refrigerating plants, however, the advantages of these media have been lessened and a more durable medium has been sought.

Theatres progressed through various stages of colored lamps, but all were expensive and did not give satisfactory results. They were not sufficiently uniform when manufactured and were subject to change of color.

The desirability of a permanent medium of satisfactory color value was well known, and many were tried unsuccess-

fully at various times. Until a short time ago their most serious handicap was that they were used with bare lamps and not with satisfactory reflecting equipments. The advantages of proper reflectors and standard lamps are readily apparent, however, and the problems of producing satisfactory media should now be simplified. The problem is to produce media which may be easily removed from reflectors and of suitable color value. The Brooklyn theatre [Paramount] opened up a whole new source of discontent when the glass supplier attemped to obtain a higher resistance to heat and consequently sacrificed color.

The theatre owner has always had closed to him the use of reflectors because of the lack of a reflector of suitable contour to give an even distribution of light on the average cove surface and small enough to allow a three-color plan. In response to our pleas, one manufacturer produced reflectors which approximately fulfilled our requirements, but there is still a decided need for concentrating reflectors of mirrored glass, in the 10, 25, 40, and 60-watt sizes, which may be spaced on 3 to 6-inch centers, but made so they may be easily equipped with colored glass lenses, and easily opened for maintenance purposes. There are no such units on the market.

This situation challenges the glassmaker's ingenuity.

Feldspar Grinders' Institute, Inc., Gets Going

Successful Meeting at Atlantic City

A meeting of the Feldspar Grinders' Institute, Inc., was held at the Ambassador Hotel, Atlantic City, September 20 and 21. Various matters of importance to the industry were discussed.

The Feldspar Grinders' Institute, Inc., representing, it is said, the producers of over 90 per cent of the American feldspar production was officially organized on July 15, 1929, to bring together the leading producers for the purpose of having a central organization, the aim of which will be the advancement of the feldspar industry in every possible way and by every appropriate means. The officers and directors of the Institute are as follows: President, Richard Wainford of Trenton, Flint & Spar Company, Trenton, N. J.; Vice-President, H. P. Margerum of Consolidated Feldspar Corporation, Trenton, N. J.; Vice-President, C. H. Peddrick, Jr. of United Feldspar Corporation, New York; Secretary-Treasurer, L. L. Hunt of Bedford Mining Company, Bedford, N. Y; Commissioner, W. J. Parker, 7 East 44th Street, New York; Directors, Norman G. Smith of Maine Feldspar Company, Brunswick, Maine, and H. G. McLear of Green Hill Mining Company, New York.

Membership List

Bedford Mining Company, Inc., Bedford, N. Y.
Dominion Feldspar Corporation, Rochester, N. Y.
Erwin Feldspar Corporation, Erwin, Tenn.
Golding Sons Company, Trenton, N. J.
Maine Feldspar Company, Brunswick, Me.
New York Feldspar Company, Lewistown, Pa.
Green Hill Mining Company, New York.
Rock Products Company, Silica, O.
Trenton Flint & Spar Company, Trenton, N. J.
United States Feldspar Corp., Cranberry Creek, N. Y.
Oxford Mining & Milling Co., West Paris, Me.
Tennessee Mineral Products Corp., Spruce Pine, N. C.

Important Matters Considered

A number of committees have been active during the past few weeks investigating matters of importance to the industry. These include a classification and standards committee, tariff committee in cooperation with the ceramic industry, transportation committee, truck delivery committee, package committee, code of ethics committee and cost accounting committee.

At the Atlantic City meeting several committee reports were presented. The cost accounting committee report recommending the adoption of a uniform method of cost accounting was adopted. The report of the classification and standards committee of which B. C. Burgess, of the Tennessee Mineral Products Company, is chairman, was adopted. The code of ethics committee, H. C. McLear, chairman, presented a code recommended by the committee dealing with trade practices in the feldspar industry which was adopted by the meeting. C. H. Peddrick, Jr., chairman of the package committee, led a discussion on the use of paper bags for shipping feldspar and it was decided by the meeting to adopt this practice.

On Saturday evening, September 21, a banquet was held at the Ambassador Hotel at which M. M. Flannery of the Federal Trade Commission addressed the meeting on Trade Practice Conferences as conducted under the auspices of the Commission.

CODE OF ETHICS
of the Feldspar Grinders' Institute, Inc.

This Institute is established to secure by lawful methods harmonius action in all matters pertaining to the best interests and welfare of Feldspar Grinders. To promote this end the members jointly agree to observe the following Code of Ethics.

1. Indirect or underhand selling or buying methods intended to influence anyone improperly is prohibited.
2. The making or circulating of false or misleading statements, either written or oral, respecting a competitor's product, service, or selling price or regarding his business, financial or personal standing is prohibited.
3. No over-statement or misrepresentation shall be made.
4. No order larger than can reasonably be delivered within the terms of the agreement shall be accepted.
5. Discrimination in prices between different purchasers or different localities based upon other than legitimate differences in costs is prohibited.
6. No attempt shall be made to persuade a customer to break a contract with a competitor.
7. No offer of employment to a competitor's employees shall be made unless, without solicitation, they ask for employment.
8. Material shall not be sold at or below cost for the purpose of annoying, harassing, or eliminating a competitor, or otherwise.
9. The permanent rendering of any unusual service or giving of terms greatly exceeding the usual trade practice is prohibited.
10. The buying of business by the payment of a commission or bonus to persons not in the seller's employ is prohibited.
11. Only such samples of products as are made from stock materials shall be submitted for the consideration of prospective customers.
12. No competitor's samples shall be used for the purpose of disparaging the quality of his product.
13. No special discounts nor rebates shall be allowed which are not reported as part of the price, and the purchaser shall be charged for the actual grade and grinding of the material shipped.
14. Dealers, salesmen and agents shall be provided with this Code and as far as possible they shall be induced to conform with it.

Feldspar

Abstract from a communication issued by Feldspar Grinders' Institute.

If it is true that our twentieth century civilization is founded on steel, it is equally true that the superstructure is largely dependent on feldspar.

Research in the field of metallic alloys made this the age of steel. A similar intensive study in the field of ceramic compounds is bringing feldspar into its own.

While variously termed Feldspar, Feltspar and Felspar, the name Feldspar is a general term in mineralogy for the most important rock-forming group of minerals. The feldspars are all anhydrous silicates of alumina, containing either potash, soda or lime alone, or two of these bases together. In the form commonly known as spar rock which is of igneous origin it appears in pegmatite for-

mations of crystalline rock masses in company with quartz, mica and other minerals, the principal deposits on this continent being located in North Carolina, New Hampshire, Maine, Connecticut, New York, Maryland and Eastern Canada.

The spar rock is procured from deposits, some of which are near the surface, others extending deep into the earth. These deposits vary both as to size and quality, the quality being determined by the chemical make-up of the rock and by the quantity and nature of the foreign substances present.

There are today so many various uses for feldspar, that to list the articles in which it is used would require a book of great volume. From scouring soap to the costliest articles of delicate beauty—from the bath tub to the most minute parts of the radio. Artificial teeth, high voltage electrical insulators and even some semi-precious stones such as the moonstone and the Amazon all contain the versatile mineral feldspar.

As a more prosaic and direct explanation of its many uses, it can be said that feldspar is indispensable in the manufacture of sanitary, electrical, chemical and medical articles as well as a great number of glass products.

Feldspar is indeed, the Jack-Of-All-Trades in the mineral family.

* * *

It would be nothing short of an insult to the average intelligence to attempt to write of the uses and importance of glass. The subject is as clear as the product itself and needs no further introduction. "See what you buy—buy it in glass"—that slogan alone very nearly defines and describes that distinguished characteristic which glass shares with so very few other elements. Its importance is as transparent as itself!

Up to recent times there is no definite evidence of the use of feldspar in glass itself, however, modern developments and research have proven its beneficial effects.

As an ingredient of glass, feldspar became of importance during the recent development of laboratory research and the rapidly increasing application of chemistry to the industries. Feldspar's peculiar adaptability to glass is shown by the fact that of the five ingredients specified for a glass suitable for X-Ray tubes, three of the five are natural constituents of the variety of feldspar known as albite. In addition to the adaptability of this raw material in the manufacture of all glassware, it plays an important part in the production of glass used to imitate marble, chiefly for table tops, floors and walls. Recent experiments have shown that feldspar gives an increased viscosity to glass which in conjunction with our modern mechanical means of production has enabled the American manufacturer to greatly exceed the Europeans in production, strength and quality.

In general, it can be said that for glass requiring a high resistance to chemical change (particularly devitrification), increased mechanical strength and viscosity, feldspar of the correct analysis is practically indispensable.

* * *

Like Topsy of Uncle Tom's Cabin fame, the feldspar industry has steadily grown and enlarged without any apparent systematic control or regulation. Like a sunflower whose seed falls on fertile soil and grows to great height without the care of either spade or hoe, so the product of the feldspar mines fell onto the fertile fields of the ceramic industry and, by the sheer warmth of its reception, it has grown to heights which were scarcely dreamed of by the original producers.

With the establishment of the first American potteries it was quite natural that their owners should look for local deposits of feldspar rather than depend on the supply from abroad. Their first success was in the New England states where still today a large quantity of spar rock is mined.

Other deposits were soon after located in North Carolina, New Hampshire, Maine, Connecticut, New York, Maryland and Eastern Canada. These deposits are today the main source of supply.

Used in practically every ceramic product, feldspar has become so familiar (in name at least) to the various ceramic industries that no particular attention is given to its origin or make-up nor to the whys and wherefores of its results. Like the typewriter or the telephone, it is spoken of as a matter of course and bought and used as a matter of necessity, but just as there is a difference in the service given and the results obtained from different typewriters and different telephones, there is an equal difference in the different grades of feldspar. Being so paramount a subject to the entire ceramic field, feldspar cannot be too closely studied by those who are so dependent upon its use. While one grade or deposit of feldspar will obtain one result, the next deposit may act entirely different.

* * *

In the early days of the industry uniformity of feldspar was not to be had. Spar rock was mined where it was easiest and most accessible, prepared by little more than guesswork and shipped when and where it was possible. Today under the technical control of able executives and chemists, it is possible to determine the exact results which any specified grade of feldspar will have and to supply the identical quality of feldspar which any manufacturing industry may desire.

The knowledge of today has superseded the guesswork of yesterday.

Spar rock is mined by both the open and tunnel process, the operation itself being somewhat different from the mining of coal, iron ore and other such minerals.

The removal of the rock itself is accomplished by explosives which are inserted into deep holes drilled in the rock at short intervals by pneumatic and electric drills. This drilling, because of the extreme hardness of the spar rock, plays a considerably more important part in spar rock mining than it does where softer minerals are removed by this process.

The mining of feldspar is a very difficult one and requires particular attention. The yield of the average mine of merchantable spar is about 25 per cent of the total rock mined. After the raw material comes from the mine it is of various sizes and shapes and contains a quantity of quartz, mica and other foreign substances.

The spar rock must next be transported to the mills. This is also an important part in the mining of feldspar, inasmuch as the feldspar deposits are, in general, located long distances away from the nearest transportation which necessitates the feldspar producer building a great many miles of trackage through the mountainous and rough country in which this particular deposit may be located.

The feldspar is then separated from these foreign substances and each piece of spar is graded and hand-picked to insure its purity. Extreme care is taken to see that feldspar containing certain chemical elements is not mixed with other feldspar containing different chemical elements. In this way it is possible to supply any particular kind of feldspar which the manufacturer desires. Some users are of the opinion that the spar rock secured by the tunnel process is of a better quality than that which is obtained from the open cut mine, although there has never been a reason given why this is the case. The important point so far as the user is concerned is that an established standard be maintained.

For years during the early development of the feldspar industry the kilns of the ceramic manufacturers were practically the only means of study and research which the feldspar producers had.

The manufacturer used the kind of feldspar that someone thought or guessed was proper and trusted to luck and the judgment of the guesser for his results. If that particular feldspar contained the correct chemical constituents, the manufacturer did his best to secure more of a similar makeup, but his efforts for the most part would be in vain more often than they were rewarded, for at that time even the feldspar producer himself could only guess that the second shipment would be the same as the first.

The expense and waste of this very unsystematic procedure was enormous. Something surely had to be done towards its elimination. Chemists were employed by the producers and the equipment of laboratories was started. The beginning of a new era dawned on the whole feldspar industry and facts started taking the place of guesswork.

Through recent years this systematic study of feldspar has progressed to a thoroughly scientific stage of research until today no part of the industry plays so important role as the modern well-equipped testing laboratory.

Deposits of feldspar are now analyzed before they are mined and a complete record is kept of their location, quality and quantity.

The formula of any user can now be adhered to year in and year out with the assurance that he can at any time secure the same feldspar in each successive shipment.

The importance of this can readily be appreciated at first thought. Indeed, the progress of the ceramic and feldspar industries can be largely attributed to the research of the chemist's laboratory.

It is quite natural that there are obstacles still to be overcome in the feldspar industry, but those already overcome have been of no less magnitude. Many of the present obstacles will be overcome by faithful cooperation between producers.

Recent Patents

NEW INVENTIONS DESIGNED TO IMPROVE GLASS AND THE MEANS OF PRODUCING IT

Complete copies of U. S. Patent Specifications may be obtained from the Commissioner of Patents, Washington, D. C. Price 10c each

Laminated Glass and Process for Producing the Same

U. S. Patent 1,727,937, September 10, 1929. James W. H. Randall, New York, N. Y., assignor to The Libbey-Owens Sheet Glass Company. Filed 8/8/27.

An improved process for producing laminated glass, wherein a preferably woven fibrous material is treated with a substantially colorless resin, the resin and material being of such a nature that in the event the material is not originally transparent, it will be rendered transparent during the course of the manufacture of the laminated sheet so that the finished product will be perfectly clear and transparent.

Another object of the invention is to treat a preferably finely woven fibrous material made of silk, rayon, cellulose esters, etc., with preferably colorless synthetic resins such as those resulting from the combination of various aldehydes with phenol, urea, thiourea, casein, etc.; glycerolphthalein resins as well as certain esters of the dibasic acids, etc., subjecting the resin-treated material preferably to the action of heat and pressure to polymerize or condense said resin or combination of resins into a transparent body, the combination of resin and fibrous material forming a material suitable for use in the manufacture of laminated glass.

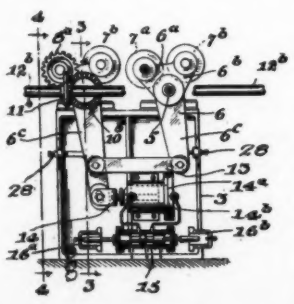
A further object of the invention is to provide a process of this nature wherein a woven fabric is treated with synthetic resins, or the like, produced by condensation, polymerization or other reaction from phenol or its homologues, formaldehyde or its homologues, furfural, phthalic anhydride, glycerol or the like, or the congeners, and then uniting the same to a sheet or a plurality of sheets of glass.

Some resins may have a partially solvent action on the fibrous materials, which others may tend to gelatinize the same, but in all events the inventor prefers to use a combination of fibrous material and resin where the resultant product will be transparent. In some instances, it may be necessary to apply heat and pressure to transform the fibrous material to a transparent member, but this is not objectionable as it is customary to unite the laminations in the manufacture of laminated glass by the action of heat and pressure. In fact, the use of heat and pressure is contemplated in the present invention. However, in some instances, the mere combination of the resin and the fabric may be sufficient to make the fabric transparent, and in some cases it may be desirable to use a suitable solvent cement or the like to assist in obtaining a bond between the laminations.

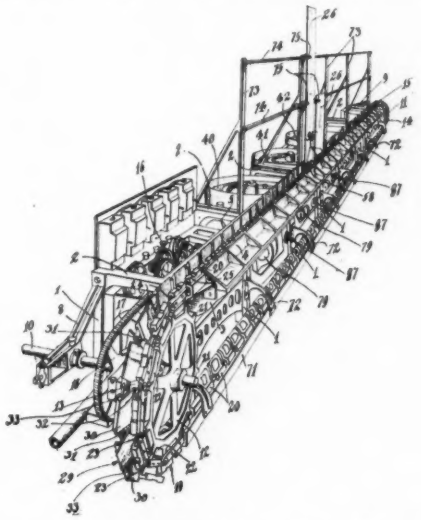
Obviously, if a colored sheet of laminated glass is desired, either the sheets may be colored or the interior membrane.

Broad claims involving the use of resins per se as the non-brittle membrane, skin coat, or both, between two sheets of glass are not made in this application because such claims are being prosecuted in my co-pending applications Serial No. 233,831; Serial No. 247,032; Serial No. 256,582; Serial No. 256,584; Serial No. 271,441; Serial No. 256,591; and Serial No. 247,031.

SPEED-CHANGING MECHANISM FOR GLASS SHEETS. U. S. 1,728,538. Sept. 17, 1929. Eugene Gentil, Paris, and Pierre Louis Aimé Mathe, of Meudon, France, assignors to the American Bicheroux Company. Filed 6/25/28. An arrangement for effecting in a simple manner the alternate raising and falling of the high and low speed rolls to effect the transfer of the sheets from the former to the latter, and for controlling such movements of them. A speed changing apparatus for glass sheets, the combination of two rollers mounted to rock around a common center to raise and lower the same reversely, a separate drive for each roller whereby the rollers are driven at different speeds, the said drives being transmitted to the rollers through the common center around which they rock, and means for rocking the rollers around such center.

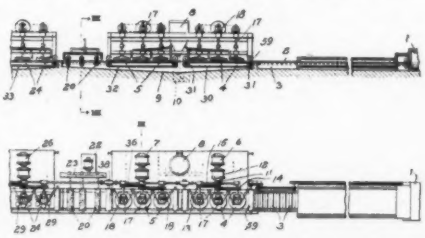


MEANS FOR BEVELING THE EDGES OF GLASS PLATES. U. S. 1,728,647. Sept. 17, 1929. Karl Albert Weber, Los Angeles, Cal., assignor to International Glass Machinery Co. Filed 7/28/26. The engaging plates 51 are first secured to a conveyor 19. The plates of glass are then inserted between the conveyors 19 and 29 with their edges 7 upon the non-abrasive strips and the yoke

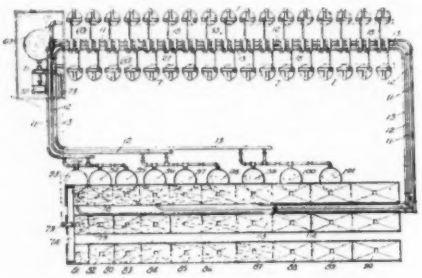


58 is actuated to clamp the same into position. The motor is then started to drive the conveyors 19 and 29 or the glass may be positioned between the conveyors 19 and 29 during the driving of the conveyors, as the drive thereof is relatively slow. The motors which drive the grinding element 82 and the grinding elements 41 and 42 are then set into operation and the plate of glass is conveyed along the frame provided by the uprights 1, past the grinding element 82, the grinding element 41, which is preferably a finer grinding stone than the grinding stone 82 and has a polishing wheel 42 which completes the grinding and polishing of the beveled edge.

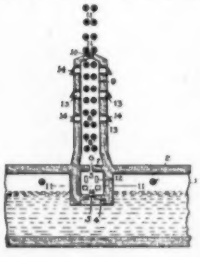
PROCESS AND APPARATUS FOR SURFACING SHEET GLASS. U. S. 1,724,704. Aug. 13, 1929. John H. Fox, Pittsburgh, Pa., assignor to Pittsburgh Plate Glass Company. Filed 10/29/23. In an apparatus for surfacing a continuously formed and annealed ribbon of glass, a series of surfacing machines, means for carrying the ribbon beneath the surfacing machines, a series of pairs of rolls following the surfacing machines with their passes arranged at increasing angles through 180 degrees for gradually turning the ribbon so as to bring its lower surface up, tubular guard members surrounding the ribbon intermediate the pairs of rolls, means for driving said rolls, a second set of surfacing machines following said series of rolls, and means for carrying the ribbon beneath the second set of surfacing machines.



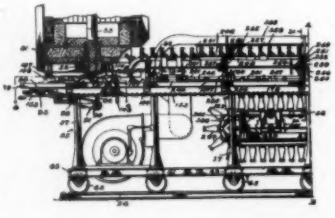
FEEDING ABRASIVES TO GRINDING MACHINES. U. S. 1,724,259. Aug. 13, 1929. Joseph P. Crowley, Toledo, O., assignor to the Libbey-Owens Sheet Glass Company. Filed 8/27/23. This invention relates to an approved process and apparatus for automatically supplying finely divided abrasive material, such as sand, mixed in water, to a plurality of plate glass grinding machines, the supply of each of the several grades of abrasive mixture being maintained in an endless pipe circuit. Parallel stretches of each of the several pipe lines extend past, and adjacent to, each grinding unit, and mechanism is provided to automatically feed a portion of the supply from any one of the pipes to each machine. For example, when the grinding operation of a machine is started a portion of the heaviest grade of abrasive is forced from its pipe line to the machine. After a suitable interval this grade is shut off and the next finer grade is fed to the machine, and so on until the grinding operation is completed, at which time the finest grade, then being used, is shut off. A continuous pressure is maintained on the abrasive supply in each pipe-line, which alternately forces portions of the material to such of the grinding machines as are using that particular grade of abrasive at the time, or forces a flow of the material through the pipe-circuit to replenish the supply of abrasive and keep the solid material in suspension. The used abrasive and water from the several machines flow to a common sump from which the better part of the mixture is pumped to a series of grading tanks. Here it is divided by a settling process into the several grades of abrasive and drained into the storage reservoirs from which the pipe lines are fed, and back into which unused abrasive is discharged.



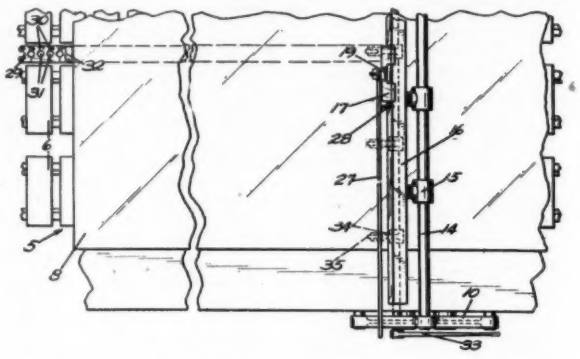
METHOD AND APPARATUS FOR DRAWING SHEET GLASS. U. S. 1,726,114. Aug. 27, 1929. William A. Morton, Pittsburgh, Pa. Filed 8/3/27. An apparatus for drawing glass in sheet form, the combination with the glass melting furnace and a stretching chamber superimposed on the furnace and communicating with the furnace through a slotted opening in the floor of the chamber, of means for bathing the sheet of glass in a stream of heated air moving in the direction of the travel of the glass and at a pressure sufficient to prevent currents of colder air impinging on the surfaces of the sheet.



MOLD MECHANISM FOR GLASS-WORKING MACHINES. U. S. 1,727,221. Sept. 3, 1929. Russell M. Searle, Albany, N. Y., assignor to Corning Glass Works, Corning, N. Y. Filed 6/3/27. This invention being to provide a compact construction by which the molds may be closed, rotated, opened and held open in such a position as to permit the removable blown articles away from the mold by a continued movement of the articles in the line of their blowing motion. This combination with a rotating member carrying separable mold parts which rotate therewith, a member rotatable in respect of the first named member, a friction drive for each of said members, locks for holding each of said members against rotation, and means for opening and closing the mold parts by the relative rotation of the members.

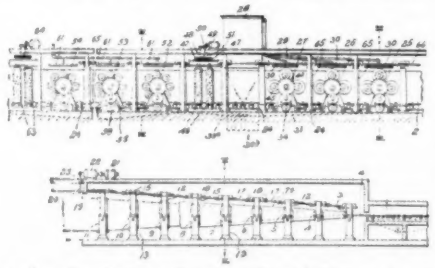


SHEET-GLASS CUTTING APPARATUS. U. S. 1,724,261. Aug. 13, 1929. John L. Drake, Toledo, O., assignor to The Libbey-Owens Sheet Glass Company. Filed 4/7/27. In sheet glass cutting apparatus, a movable table for supporting a continuously moving sheet, a cutter guide extending across the sheet and movable

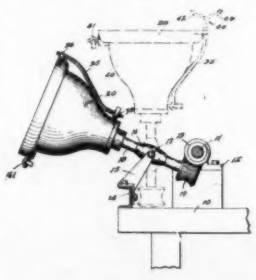


therewith, a cutter carrying member slidably mounted on the cutter guide and movable across the sheet, a cutter holder carried by the cutter carrier and vertically movable with respect thereto, a cutter carried by said holder and movable vertically into and out of engagement with the sheet, a lever connected at one end to said holder, and a fulcrum carried by the lever intermediate its ends and adapted to engage the cutter guide so that upon rocking of the lever the cutter holder and cutter may be moved vertically with respect to the glass.

PLATE-GLASS TRANSFER APPARATUS. U. S. 1,724,703. Aug. 13, 1929. John H. Fox, Pittsburgh, Pa., assignor to Pittsburgh Plate Glass Company. Filed 10/29/23. The invention relates to a process and apparatus for surfacing plate glass which is formed in a continuous ribbon. It has for its primary object the cheapening of the glass surfacing operation (grinding and polishing) by eliminating the requirement for cutting it into sections and securing the glass to the tops of surfacing tables by plaster or other means as has heretofore been done. It has for its further object the shortening of the surfacing operation by the provision of procedure and means whereby the glass is ground and polished on its two surfaces simultaneously. Among the inventor's claims is an apparatus for surfacing a continuously formed ribbon of glass after it is annealed, which consists of a series of pairs of rolls with the planes of the passes there between successively departing more and more from that of the first pass and with that of the last pass at right angles thereto, a plurality of pairs of surfacing machines arranged along the path of the ribbon with the members of each pair in opposition, and means for driving the machines.



APPARATUS FOR SILVERING GLASS MOLDS. U. S. 1,726,974. Sept. 3, 1929. Blasius Bart, East Orange, N. J., assignor to Bart Reflector Co., Inc., Newark, N. J. Filed 1/16/25. Apparatus for forming a silver shell on a glass mold as one step in the method of forming the reflecting surface of a metallic reflector. The invention is to deposit silver so as to form a thin, homogeneous layer of silver, nickel or equivalent metal, free of air holes, impurities or other deleterious characteristics which might interfere with the formation of the electrolytically deposited backing for the same.



Knox-O'Neill Discusses Vacuum Bottle Machine Situation

The O'Neill Machine Company Will Manufacture New Invention

EDITORIAL NOTE:—A letter reproduced below just received from R. R. Underwood, secretary and general manager of the Knox Glass Bottle Company, Knox, Pennsylvania, discusses the adopted plans of that company for continuing in affiliation with the O'Neill Machine Company the development, marketing and "servicing" of their new vacuum bottle-making machine which was announced to the trade last spring. In view of the wide interest manifested by the trade during the past six months in this new machine we print the letter, which is self-explanatory.

To the Editor of THE GLASS INDUSTRY:

"We wish to give you the following information for the October issue of THE GLASS INDUSTRY, which has reference to the development of the Knox-O'Neill Vacuum Bottle Machine and the acquisition of a substantial interest in the O'Neill Machine Company acquired by the Knox-O'Neill Company on or about August the 15th last.

"In view of the fact that most manufacturers of glass containers throughout the States are interested in the development of any new machinery which may be capable of a better quality than heretofore available, we feel that the trade in general should be advised of our progress in connection with the Knox-O'Neill machine.

"We have to date sold, and contracted to deliver, approximately ninety-five (95) of such machines, consisting of both our Model 60 and Model 70. At present we have in production in each of the following plants a Model 60 machine, namely: W. T. Rawleigh Company, Freeport, Illinois; Hart Glass Manufacturing Company, Dunkirk, Indiana; Carr-Lowrey Glass Company, Baltimore, Maryland; Whitall-Tatum Company, Millville, New Jersey; Owens-Illinois Glass Company, Alton, Illinois; and Knox Glass Bottle Company, Knox, Pa.

"These machines were placed in the above respective plants and immediately began making bottles. Some of the manufacturers have reflected a very highly satisfactory production record. Others have experienced minor difficulties which are fast being overcome due to their familiarizing themselves with the structure of the machine and the assistance available to each and every one of our customers by our Engineering Department in Toledo, Ohio.

"At present we are installing our Model 70 machine in the plant of the Knox Glass Bottle Company, Knox, Pa. This machine, together with Model 60 heretofore installed in the above plant, will be placed in production about October 1st. We have already extended to many inquiring prospective customers an invitation to view this operation during the month of October. The response we have received has been miraculous and therefore we anticipate demonstrating the Model 60 and Model 70 machine in operation on the same furnace to the most prominent manufacturers in the glass container industry throughout the country.

"We believe that there should be something further said in regard to our experience in connection with the operation of our Model 60 machine. It entered the glass March 4th last. This machine has now been placed in the hands of several manufacturers, elsewhere referred to, and of course has been subjected to various operations when several distinct and separate organizations began working out their own problems.

"Notwithstanding the fact that the machine entered the glass only last March, the percentage of packed glass against revolution per minute of the machine has been highly satisfactory, with the exception of a few cases where furnace and mold problems were the elements which were not fully overcome by one or two manufacturers. However, these manufacturers appear to be very well satisfied with the fundamental operation and are now insisting upon delivery of other machines, particularly our Model 70, which carries eight blank molds and eight blow molds, designed and constructed for the purpose of manufacturing the larger size containers. It is to be noted that possibly our machine has been one among very few container manufacturing machines which have entered the glass and began making bottles without serious difficulty.

"We also wish to advise the trade that we have not been unmindful of building a substantial organization for the purpose of developing and servicing our machines. It has been mentioned elsewhere that we have acquired a substantial interest in the O'Neill Machine Company, which is directed and will continue to be directed by the veteran glass machinery builder, Mr. Frank O'Neill. And it is around him that the structure is proposed to be developed. He is causing the O'Neill Machine Company to be reorganized, consolidating all of his several interests to a large extent and has already completed a new addition to the plant in Toledo, which will be occupied and owned by the O'Neill Machine Company. Adequate machine shop equipment has been purchased and now installed in our new plant at Toledo for the purpose of producing our vacuum machine. We have at present approximately one hundred persons employed in our plant at Toledo.

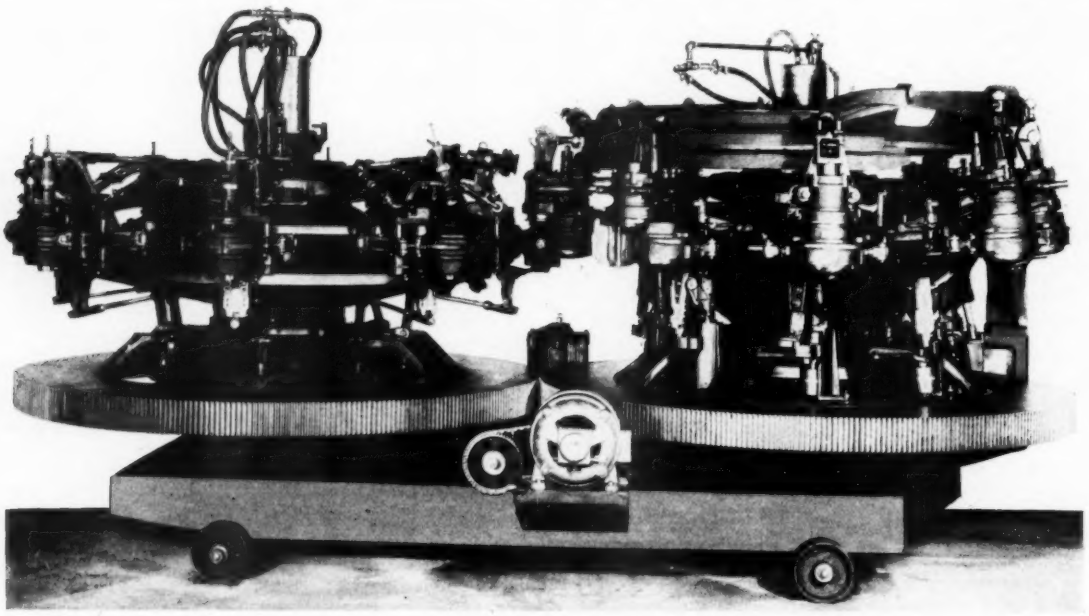
"The organization under the direction of Mr. Frank O'Neill is being departmentized by Mr. C. C. Kinker, who with the assistance of Mr. O'Neill, has been responsible in a large measure for the unique working parts and structure of our machine. Mr. Kinker is exercising great care in connection with designing and applying improvements, taking into consideration that such improvements must be so designed and constructed as to permit their incorporation in our machines which have already been sold and are now in production.

"We might also add, in this connection, that Mr. Kinker serves the O'Neill Machine Company in the capacity of Chief Engineer, and he is spending as much time as possible with the manufacturers who have our machine in production, for the purpose of familiarizing himself with the practical operation so as to afford further developments. The efficiency of the several departments under the direction of Mr. Frank O'Neill is fast being reflected throughout the entire organization.

"We have not only put forth every effort humanly possible to construct, develop and service our machines, but we have also been mindful that our machines must be fully protected, in so far as it is possible for us to protect them, from a patent point of view. To this end we have employed in our legal department, Mr. Earle L. Parmelee of the law firm of Byrnes, Stebbins, Parmelee and Blenko, Pittsburgh, Pa. Mr. Parmelee is covering, and will continue to cover, each and every patent claim filed on our machine. Associated with Mr. Parmelee is Mr. George E. Kirk of Toledo, Ohio, who has in a very masterful way been responsible for the claim structure of our machine. These two gentlemen are available at all times to our customers, as well as to our prospective customers, for the purpose of enlightening them on any patent question which may arise.

"We also wish to advise our customers, as well as our prospective ones, that while we were negotiating sometime ago with another very prominent glass working machinery company in connection with the sale of our business, these negotiations have been definitely called off and closed and it is our purpose to construct, develop and service our machines as the Knox-O'Neill Company who are the sole distributors for the O'Neill Machine Company. The latter company continues to be managed and directed by Mr. Frank O'Neill.

"We feel that in justice to ourselves the trade should be fully cognizant with the fact that we are not in any way connected or negotiating with any other glass machinery company. Our machine will continue to be sold upon an outright basis, not being subjected to any royalty charges, etc. And this phase of our proposition should be very interesting indeed to a manufacturer of glass containers, due to the low price levels prevailing throughout the market



NEW KNOX-O'NEILL VACUUM BOTTLE-BLOWING MACHINE

at this time. In fact, the saving effected by our machines, notwithstanding the fact that we claim more and better bottles from a royalty point of view, is substantial enough to warrant the consideration of any up-to-date manufacturer.

"In conclusion we wish to assure our users, as well as those whom we are anxious to count among our users, that we are not going to leave one stone unturned in developing and servicing our machine consistent with good business. At present our Engineering Department in Toledo is organizing a service which will meet with the approval of all manufacturers we are sure who are now, or may be later, interested in operating what we think is one of the most wonderful glass container making machines that has ever been offered to the glass industry, and we feel every claim made for this machine will be fully vindicated within another year.

We also feel that the trade will be interested to learn something about the structure of the Knox-O'Neill Company, and in this connection it is to be noted that all the outstanding stock of the Knox-O'Neill Company is owned and held by the Knox Glass Bottle Company, Knox, Pa.

The Knox-O'Neill Company was effected as our Engineering Department for the sole purpose of rounding out the practical operation of our machine after it has been installed in the plants of our respective customers. Mr. H. C. Ganter, formerly connected with the Atlantic Bottle Company, Tarentum, Pa., in the capacity of their factory superintendent, heads this department. Mr. Ganter is a mold maker by trade. During past years he had complete charge of the production department of the Atlantic Bottle Company, and the results of his efforts during these past few years in that capacity speak very commendably for him. He is devoting his entire time designing better and more practical fabricating methods.

"It is with some degree of practicability that our machine is covered, not only while it is passing through the construction departments in Toledo but after it has been placed in the several factories, until good bottles have actually been made and packed.

"The Knox-O'Neill Company proposes to familiarize all of the larger buyers of glass containers during the next two years with vacuum machine made bottles. It is their intention to carry on an educational program extending it into the organizations of large users of bottles and pointing out the benefits incident to a vacuum machine made container. Of course all glass container manufacturers appreciate how difficult it is to produce a crystal-clear, uniform distributed container by any other means than a vacuum process. And therefore, our efforts in this connection should produce results not only for our users but for those whom we hope to number among the users of our machine.

"R. R. Underwood, secretary and general manager of the Knox Glass Bottle Company, serves the Knox-O'Neill Company as their president; L. D. Richardson, treasurer, and C. R. Underwood, secretary and general manager."

Knox, Pa.
Sept. 24th, 1929

(Signed) R. R. UNDERWOOD"

New Publications

MINERAL RAW MATERIALS. Trade Promotion Series No. 76, Bureau of Foreign and Domestic Commerce, U. S. Department of Commerce, Washington, D. C. A survey of commerce and sources in major industrial countries by J. W. Furness, Chief of Minerals Division, Bureau of Foreign and Domestic Commerce, L. M. Jones, Bureau of Mines, assisted by F. H. Blumenthal, Minerals Division. 278 pages. Price 45 cents. For sale at U. S. Government Printing Office, Washington, D. C. Metals and non-metals are surveyed by countries including the United States, Germany, France, United Kingdom, Japan, Belgium, Italy, Spain. Part II comprises a survey by minerals, including aluminum and bauxite, antimony, chromite, copper, iron, lead, manganese ore, mercury, nickel, tin, tungsten, zinc. The following non-metal materials are also reviewed: Asbestos, barite, china clay, coal, fluorspar, graphite, gypsum, magnesite (crude), mica, nitrates (natural), petroleum, phosphates, potash, pyrites, sulphur, talc and soapstone. The relative position as producers and consumers of the principal minerals and the percentage of world producton of the materials under review by principal producing countries are given in tables. A brief bibliography is appended.

THE AMERICAN STANDARDS ASSOCIATION, 29 W. 39th Street, N. Y., recently issued its 1929 year book. During the year the American Standards Association replaced the old American Engineering Standards Committee and its administrative department has been completely reorganized. In a review of the Association's work of the year it is stated that new standards in almost every field of industrial activity have been adopted during the past twelve months and many new projects have been initiated. The methods of work followed by the organization and some of its accomplishments are outlined. A long list of the standardization projects under way is given, also the constitution, by-laws, and code of procedure of the Association.

The Glass World and What It Is Doing

News of the Industry

To Publish Monumental Encyclopedia of Ceramics

Early this Autumn, according to an announcement just made by Ernest Benn, Limited, the noted London publishing house, there will be issued "An Encyclopedia of the Ceramic Industries," by Alfred B. Searle of Sheffield, England, well known as the author of "The Chemistry and Physics of Clays" and other standard works and prominent as an analytical chemist and consulting technologist. Convinced that the ceramic industries in general might make more rapid progress if the practical man could avail himself to the full of the results of modern scientific research and if the technologist in turn were more fully acquainted with works practice, Mr. Searle set himself to the formidable task of collecting and presenting in a compact form the whole body of knowledge, scientific, technical and artistic, that exists for the ceramic industries of today. The work involved the examination of a vast library of treatises, monographs, and scattered papers in many languages.

The work is designed as a guide to the materials, methods of manufacture, means of recognition, and testing the various articles produced in the clayworking and allied industries including clays, silica, feldspar, brick, tiles, pottery, porcelain, pencils, refractory materials and many others, arranged in alphabetical order for rapid reference by manufacturers, research workers, students, connoisseurs and others.

The Encyclopedia is to be issued in three volumes, Royal 4to, which contain over 1,200 pages with numerous illustrations. Price nine pounds, nine shillings, net. Published by Ernest Benn, Limited, Bouverie House, Fleet Street, London, E. C. 4, England.

Use of Ultraviolet Ray Transmitting Glass Increases

A manufacturer of ultraviolet ray transmitting glass recently announced that a great building 24 stories in height for the United Shoe Machinery Company, which will dominate Boston's skyline, will have every window glazed with ultraviolet ray transmitting glass.

Workers in the new skyscraper will thus have available for them the same glass that is installed in the homes of the Prince of Wales, Lloyd George, and George Bernard Shaw. It was this glass that gave the name "Sunshine House" to Craigwell House, where King George of England was sent to convalesce after his recent illness.

In this country, ultraviolet glass is being extensively employed in hospitals, hotels and apartment houses. New England installatons include the South Boston Health Union, the New England Peabody Home for Crippled Children, at Newton, Mass., and the Children's Home of Boston.

More recently it has begun to be used in office buildings. Skyscrapers of other cities, notably the Fisher Building in Detroit, the St. Francis Hotel in San Francisco and the Equitable Trust Building of New York are partly or wholly equipped with it.

General Electric Consolidates Distributing Corporations

Effective October 1, 1929 the fourteen wholesale distributing corporations owned by the General Electric Company will be consolidated into the General Electric Supply Corporation (of Delaware). These companies have for many years distributed general Electric products and the plan involves no change of ownership. The consolidated corporation will be in a much better position to offer nation-wide service through its ability to give service from any one of seventy-six houses, through interchangeability of stocks, and speedier and more economical operation.

The principal officers of the new corporation, tentatively, are Gerard Swope, chairman of the board, and C. E. Patterson, President. Twelve directors have been selected. L. R. Link will be secretary and treasurer, L. M. Nichols, Comptroller. The department heads, district managers and other officers will be announced when appointed October 1st.

English Firm Investigating Glassmaking Materials

W. Astles of The Cookson Produce and Chemical Company, Ltd., Port of London Building, Trinity Square, London, England arrived at New York on September 8 for the purpose of investigating the possibility of extending the company's export and import business in glassmaking materials in this country. Mr. Astles intends to visit several cities in the Middle West. The buying and selling of raw materials for the glass industry is one of the important divisions of the Cookson Produce and Chemical Company, Ltd., which conducts a large business in certain specialties with glass manufacturers in various parts of the world.

The present company is an outgrowth of the original Cookson Company, Ltd., established 1704. It now has branch offices in Warsaw, Danzig, Lodz, Kattowitz, Galatz, Bucharest, Varna, Paris and Hamburg, with important branch offices and representations throughout the chief cities in the British Isles. Mr. Astles is desirous of interviewing manufacturers of certain heavy chemicals and coloring oxides produced in the United States and states that he would be glad to have any concerns interested in these or similar materials address correspondence to him care of Messrs. Renouf & Co., Inc., 111 Wall Street, New York, N. Y.

Manganese Producers' Convention

The American Manganese Producers Association held its second annual convention at Washington, D. C., September 9 and 10. Various speakers reviewed the progress made in their respective fields during the past year. Dr. J. S. Grasty, consulting engineer, in reporting on deposits in Virginia stated that of the total 300 deposits in that state only a few had been prospected and the problem of manganese mining was not one of lack of ore, but of selling the ore under the present market conditions.

The Association went on record as solidly backing the tariff provisions contained in Senator Oddie's amendment, namely, a tariff of 1½ cents per pound on the metallic manganese content of all ores over 25 per cent manganese with protection for low grade ores; such a tariff, it is asserted, being the minimum protection under which proper development of the industry can go forward.

At the business session on Monday, officers were re-elected for the coming years, as follows: J. Carson Adkerson, president; John H. Cole, vice-president; A. J. Seligman, treasurer; H. A. Pumpelly, secretary, and Richard H. Brown, chairman of the Board.

Changes in Glass Container Association Staff

Dr. S. Henry Ayres has resigned as Research Director of the Glass Container Laboratories in New York and has been succeeded by Karl L. Ford, who will ably carry on the work successfully conducted under Dr. Ayres' supervision. Mr. Ford became connected with the Glass Container Association in January, 1922. He has specialized particularly in the processing of glass containers.

A. G. Osborn and E. L. Voight, who recently left the Laboratory, are now engaged in research work for the Anchor Cap & Closure Corporation. P. R. Nelson, Franklin Slater, H. R. Stevenson and William Lang are new members of the Laboratory staff. Following the death of Fred J. Rummel on September 3, noted elsewhere, E. G. Ackerman has taken over his work as assistant business manager.

August Construction Contract Record

The August contract record in the 37 States east of the Rocky Mountains showed a somewhat pronounced decline following the favorable record established during the preceding month, according to the F. W. Dodge Corporation. The month's volume amounted to $488,882,400, a decline of 25 per cent when compared with the July total and a decline of 5 per cent when compared with August of last year.

The Tariff Situation

The stiff fight being waged against the passage of the tariff bill in the form recommended by the Senate Committee continues with increasing intensity. Strong opposition to increasing import duties on various products has developed. A number of the members of the Senate have taken the stand that many of the industries which would be benefited by increased import duties do not really need them. It is claimed that they have been and still are making huge profits under the present tariff and that no increase is necessary to save them from ruinous foreign competition. In response to demands that the situation be investigated the Senate Finance Committee on September 18 voted 10 to 4 to make public the list of corporations whose income tax statements of profits and other data, have been requested from the Treasury by the Democratic members under the authority of Senator Simmons' resolution, for use during the debate on the tariff bill.

Hundreds of manufacturers in many industries have been publicly listed, including a number of glass manufacturing concerns, chemical producers, and others more or less associated with the glass manufacturing industry. Among these are the American Plate Glass Company, American Window Glass Company, Advance Plate Glass Company, Libbey-Owens Glass Company, National Plate Glass Company, Pennsylvania Wire Glass Company, Standard Plate Glass Company, Mississippi Glass Company, Morris Glass Company and Vitaglass Company. Strong opposition has also been shown to the provision in the Senate bill perpetuating the flexible provisions of the tariff. In a statement made public on September 4, President Hoover urged that the flexible provisions of the tariff bill (HR 2667) be retained by Congress. He declared that he regards it as of the utmost importance in justice to the public and for the protection of sound progress in the nation's economic system and also for the protection of farmers, industries and consumers that the flexible provision shall not be eliminated. Opinion at Washington in general is that there is but little prospect of the tariff bill being finally acted upon before December.

New Ultraviolet Ray Transmitting Glass

An improved ultraviolet ray transmitting window glass has been announced as on the market by Fish-Schurman Corporation, 45 West 45th Street, New York, who are American agents for Schott & Gen., Jena, Germany, well known manufacturers of optical, technical and scientific glassware. The new glass is called Uviol-Jena and according to a statement made by Murray Yawitz, who is connected with the United States distributors, the new glass transmits 70.5% before solarization and 51.5% after solarization at a wave length of 302mu. Mr. Yawitz suggests that anyone desiring to verify this statement can do so by forwarding a piece of their glass to the Bureau of Standards, at Washington, D. C.

Recently Equipped Arnold Plant Begins Production

A few days ago the American Window Glass Company announced that fires had been lighted in their Arnold, Pa., plant, which has been equipped with 13 Fourcault window glass drawing machines of improved type capable of drawing extra wide flat sheets of glass continuously. It is stated that the large new furnace supplying glass to the 13 drawing machines will be capable of producing approximately 4,500 boxes of glass every 24 hours.

Receivership of H. C. Fry Glass Company Ended

Reorganization has taken place of the H. C. Fry Glass Company of Rochester, Pa., which recently has been under control of Edward T. Davis, as receiver. This temporary receivership has been brought to a close. Mr. Davis will continue to be interested in the company as secretary. The other officers recently elected were John W. Ailes, banker of Pittsburgh, who is chairman of the board, S. C. Stebbins, president, formerly with the United States Glass Company in an executive capacity. G. K. Fry, vice-president has been in charge of the general sales department for several years past and will continue in that capacity. Mr. Mitchner is treasurer of the Rochester Trust Company and other local institutions.

Predicts Another Large Safety Glass Plant

A Boston newspaper on September 13 published a report that Mayor Bernard W. Doyle of Leominster, Mass., vice-president of the Dupont Viscoloid Company, had announced that the company will start work at once on the erection of a $1,000,000 building in connection with its Leominster plant, to manufacture a new type of safety glass for automobiles.

Feldspar Production in August

The production of feldspar in August, this year, is reported to have been approximately 16,000 tons, of which nearly 7,000 tons were shipped to glass factories. The next largest consuming trade was the electrical industry, the requirements of which were approximately one-third that of the glass manufacturers.

Large Increase in Plate Glass Production

The production of polished plate glass in August was 14,716,467 sq. ft., an increase of more than 1½ million feet over the July production. August, 1929 production increased 2,557,351 sq. ft. over the August, 1928, figure of 12,159,116 sq. ft. These are the statistics compiled by P. A. Hughes, secretary of the Plate Glass Manufacturers of America.

New Vice-President for Buck Glass Company

Royden A. Blunt, formerly general manager of the Buck Glass Company, bottle manufacturers of Baltimore, Md., was elected at a recent meeting to the office of vice-president. Arthur F. Barstow, formerly purchasing agent, was elected secretary of the company. Their many friends in the industry will be greatly pleased to learn of these advancements.

Glass Container Association to Meet at Toronto

The Fall meeting of the Glass Container Association will be held October 17, 18 and 19 at the Royal York Hotel, Toronto, Ontario. Hotel accommodations have been reserved by the association. The program for the meeting has not yet been issued.

Trade Activities

The Pennsylvania Bottle Company's plant at Sheffield, Pa., was forced to shut down early in September due to a break in the tank.

Ball Brothers Company, according to a report from Hillsboro, Ill., have closed down their factory in Schram City for an indefinite period.

The Pittsburgh Plate Glass Company declared a regular quarterly dividend of 50 cents payable October 1 to stock of September 10 record.

The Dominion Glass Company, Ltd., Montreal, Quebec, has declared regular quarterly dividends of $1.75 each on common and preferred, both payable October 1 to stock of record of September 15.

The Pennsylvania Salt Manufacturing Company during the fiscal year ending June 30 recorded net earnings as $1,495,939 equal to $9.97 a share, a substantial increase over the earnings of the previous year.

The Paul Wissmach Glass Company, Paden City, W. Va., is planning to start up their wire glass department early in October. The company also manufactures sheet glass in colors and other specialties.

E. H. Hobbie of the Mississippi Glass Company, N. Y., has been elected general secretary of the Illuminating Engineers Society, whose annual convention has just been held at Philadelphia from September 24 to 27.

The Scohy Sheet Glass Company, Sistersville, W. Va., have resumed manufacturing operations in their fourcault plant at Sistersville, W. Va. It is expected that operations will be continued uninterruptedly over a very long period.

H. C. Fry Glass Company, Rochester, Pa., has engaged D. J. Sullivan formerly connected with the United States Glass Company, Factory F at Pittsburgh to take charge of the specialty division of the company's Rochester, plant.

The Dunbar Flat Glass Corporation, Dunbar, W. Va., is reported to be expending about $200,000 for an addition to their plant. The improvements are said to include a new 30 ton tank, two annealing lehrs, an up-to-date batch mixer and other modern improvements.

The Perfection Glass Company of St. Marys, W. Va., announced early in September the purchase of the plant of the Kauffeld Glass & Ceramics Company, Star City, W. Va. J. L. Jaffe of Cleveland, O., is president, M. R. Davis of Star City, secretary, and C. St. Clair, treasurer.

The Fostoria Glass Company, Moundsville, W. Va., have stated through their president, C. B. Roe, that rumors in regard to the reported purchase by the company of 25 acres of land at Glendale "for the erection of a new factory" were not well founded. Mr. Roe stated that while negotiations for certain lands have been carried on the company has no intention of building another factory at this time or in the immediate future.

Recent Deaths

Fred J. Rummel

The trade, particularly those connected with the glass container branch were saddened to hear of the death on September 3 of Fred J. Rummel from an attack of pneumonia following an operation on August 14 for appendicitis. Mr. Rummel will be greatly missed by all who have been in contact with the Association officers and the frequent conventions. His work will be taken up by E. G. Ackerman, who has been in charge of the statistical department of the association.

James L. Foster

James L. Foster, well-known throughout the industry by reason of his connection as Pittsburgh manager of the General Chemical Company, died in that city on September 6 at the age of 63. He had been connected with the General Chemical Company for nearly half a century.

Coming Meetings

The Glass Container Association will hold its Fall meeting at the Royal York Hotel, Toronto, Canada, October 19 to 21.

The American Society of Mechanical Engineers will hold its annual meeting in New York City during the first weeks of December.

The National Power Show, the annual exposition of the power and mechanical engineering, will be held at the Grand Central Palace, New York during the week beginning December 2.

The American Bottlers of Carbonated Beverages will hold their annual convention and exposition in the new $15,000,000 Atlantic City Auditorium and Convention Hall, November 11-15. Bottle manufacturers who have already reserved exhibition space are the following: American Bottle Co., Chattanooga Bottle & Glass Manufacturing Co., D. O. Cunningham Glass Co., Glenshaw Glass Co. Inc., Graham Glass Co. Laurens Glass Works, Pierce Glass Co., F. E. Reed Glass Co., Root Glass Co., Three Rivers Glass Co.

The Society of Glass Technology has issued a program of its meetings to be held in England during the session 1929-1930, as follows: October 16, Sheffield, November 20, Leeds, December 18, London, January 15, 1930, Sunderland, February 19, Sheffield, March 19, Stourbridge, April 16, Sheffield (annual general meeting), June 3, 4 and 5, London, (joint meeting with the Deutsche Glastechnische Gesellschaft). The joint meeting with the German Society will probably take the place of the usual meetings in May and June.

The Fuels Division of the American Society of Mechanical Engineers will hold its third national meeting at the Bellevue-Stratford Hotel, Philadelphia, Oct. 7-10. An elaborate program of entertainment has been prepared. At the opening session Prof. R. H. Fernald of the University of Pennsylvania will deliver the opening address on The Fuel Engineer, His Training, and Work. On Tuesday morning at the industrial session Victor J. Azbe, consulting engineer, will present Fuel Burning in Ceramic and Lime Industries. Many other subjects will be dealt with. Sessions devoted to the power plant and industrial, domestic, and smoke abatement problems will be held.

What the World Wants

Specific inquiries for American Goods Received in the Department of Commerce, Washington, D. C.

France—40850, Diamonds and wheel type glass cutters, painters' cutlery.

Czechoslovakia—40679, Technical apparatus for glass, paper, textile and sugar industries.

Domestic—40909, building glass.

Bolivia—40989, plain glass, mirrors and frames.

Canada—41017, tableware glass, especially tumblers.

Domestic—41015, glass tobacco jars.

Honduras—40911, field glasses.

South Africa—40877, table glassware.

Inquiries Received

For further information address THE GLASS INDUSTRY

470. Please give us the names and addresses of manufacturers that can furnish glass cullet in strong colors, such as blue, green, red, orange, etc., to be used for stucco dash and roofing granules, preferably cullets which are discarded as by-products.

471. Kindly inform us as to where we may obtain "calcined oats."

472. Please refer me to a source of information relative to the optical glass industry in the United States, the quantity manufactured, imported and exported and any other similar information available.

READERS' WANTS AND OFFERS

For Sale: **CULLET** of all Descriptions
Free from Caps, Wires, etc.
GEORGE F. BAUMANN, Dealer,
1110 Carroll Street, Brooklyn, New York.
Carloads Ready for Immediate Shipment.

The New York Public Library in order to complete its files, desires to obtain copies of The GLASS INDUSTRY—issues of Vol. 2 (1921) May, June, and August numbers. Will anyone in possession of these copies and willing to part with them kindly address The GLASS INDUSTRY, 50 Church Street, New York.

GLASS PLANT BARGAIN

For Sale or Lease
on
Startling low terms

Completely equipped glass plant for wide-mouth and pressed and blown ware, also adaptable for diversified line. Convenient to raw materials. Excellent shipping facilities. Low taxes. Delightful living conditions; plant and location offers every desirable feature for manufacturer who desires to expand or relocate his plant. Detailed information on request.

Massillon Industrial Commission
Massillon, Ohio

Current Prices of Glass-Making Materials

September 20, 1929

Quotations furnished by various producers, manufacturers and dealers.

		Carlots	Less Carlots
Acid			
Citric (dom.)	lb.	.46	.46
Hydrochloric (HCl) 20° tanks, per 100 lb		..	1.10
Hydrofluoric (HF) 60% (lead carboy)	lb.	..	.13½
52% and 48%	lb.	.10	.10-.11½
Nitric (HNO_3) 38° carboy ext. Per 100 lb.		5.50	5.75
Sulphuric (H_2SO_4) 66° tank cars	ton	15.50	..
Tartaric	lb.	..	.38
Alcohol, denatured	gal.	..	.52
Aluminum hydrate ($Al(OH)_3$)	lb.	.04½-.05	.05½-.06
Aluminum oxide (Al_2O_3)	lb	..	.07
Ammonium bifluoride (NH_4) FHF	lb.	..	.21-.22
Ammonia water (NH_4OH) 26° drums	lb.	.03	.03¼
Antimony, metallic (Sb)	lb.	..	.09¾
Antimony oxide (Sb_2O_3)	lb.	..	.12-.14
Antimony sulphide (Sb_2S_3)	lb.	..	.14
Arsenic trioxide (As_2O_3) (dense white), 99%	lb.	.04	.05
Barium carbonate ($BaCO_3$)			
Precipitated	ton	57.50-59.50	60.00-61.50
Natural, powdered, imported	ton	45.00	50.00
Barium hydrate ($Ba(OH)_2$)	lb.	..	.04¾-.05½
Barium mixture, glassmaker's, f.o.b. St. Louis	ton	25.00	..
Barium nitrate ($Ba(NO_3)_2$)	lb.	.08¼	.08½
Barium selenite ($BaSeO_3$)	lb.	..	..
Barium sulphate, in bags	ton	..	..
Barium sulphate, glassmaker's, carlots, bulk, f.o.b. shipping point,	ton	15.00-16.00	18.00
Barium mixture, glassmaker's, f.o.b. St. Louis	ton	25.00	..
Bone ash	cariots, lb.	.06	.06½
Borax ($Na_2B_4O_7 10H_2O$)	lb.	.02½-.02¾	.02¾-.03¾
Boric acid (H_3BO_3)	lb.	.05½-.05¾	.06-.07
Refined	lb.	.05½-.05¾	.06-.07
Cadmium sulphide (CdS)—			
Red	lb.	..	1.20
Orange	lb.	..	1.00-1.25
Yellow	lb.	..	1.20-1.40
Chromium oxide (Cr_2O_3)	lb.	.24	.25
Cobalt oxide (Co_2O_3)			
In bbls.	lb.	..	2.10
In 10 lb. tins	lb.	..	2.20
Copper oxide			
Red (Cu_2O)	lb.	..	.30
Black (CuO)	lb.	..	.28-.30
Black prepared	lb.	..	.30
Cryolite (Na_3AlF_6) Natural Greenland Kryolith)	lb.	.09	.10-.10½
Artificial or Chemical	lb.	..	.09½
Epsom salts ($MgSO_4$) (imported) Per 100 lb.		..	1.15-1.20
Feldspar—			
100 mesh	ton	11.00-12.50	20.00 12.50-22.00
80 mesh	ton	11.00-11.75	14.50
40 mesh	ton	11.00	13.50
Fluorspar (CaF_2) domestic, ground, 95-98% (max SiO_2, 2½%)			
Bulk, carloads, f.o.b. mines	ton	32.50	..
In bags or barrels	ton	36.50	41.50
Formaldehyde	lb.	..	.08¾-.09¾
Graphite (C)	lb.	..	.04-.07
Iron oxide—			
Red (Fe_2O_3)	lb.	..	.03¼-.03½
Black (FeO)	lb.	.03½	..
Kaolin (f.o.b. mine)	ton	9.00	..
English, lump, f.o.b. New York	ton	14.50-25.00	24.50-30.00
Kryolith (see Cryolite)			
Lead chromate ($PbCrO_4$)	lb.		
Lead oxide (Pb_3O_4) (red lead)	lb.	.094	.10¼
Litharge (PbO)	lb.	.084	.09¼
Lime—			
Hydrated ($Ca(OH)_2$) (in paper sacks)	ton	6.50-9.50	..
Burnt (CaO) ground, in bulk	ton	8.00	..
Burnt, ground, in paper sacks	ton	10.00-11.00	..
Burnt, ground, in 280 lb. bbls.	Per bbl.	2.15-2.25	2.30-2.60
Limestone ($CaCO_3$)		2.00-2.50	..
Magnesia (MgO)—			
Calcined, heavy (in bbls.)	lb.	.06	.07
light (in bbls.)	lb.	..	.23
extra light (in bbls.)	lb.	..	.37
Magnesium carbonate ($MgCO_3$)	lb.	.06	.07
Manganese 85% (MnO_2)	lb.	.04	.04½
Nickel oxide (Ni_2O_3), black— for nickel content	lb.	..	.35-.35½
Nickel monoxide (NiO), green— for nickel content	lb.	..	.35-.35½
Plaster of Paris, bags	ton	..	23.00-29.00
Potassium bichromate ($K_2Cr_2O_7$)—			
Crystals	lb.	.09	.09¾
Ground	lb.	.11	.12
Potassium carbonate—			
Calcined (K_2CO_3) 96-98%	lb.	.06½	.07
Hydrated 80-85%	lb.	.05¾	.06¼
Potassium chromate (K_2CrO_4)	lb.	..	.23-.32
Potassium hydrate (KOH) (caustic potash)	lb.	.07⅛	.08
Potassium nitrate (KNO_3) (gran.)	lb.	..	.05⅞-.06
Potassium permanganate ($KMnO_4$)	lb.	.16	.16½
Powdered blue	lb.	..	24-.26
Rochelle salts, bbls.	lb.	..	.23
Rouge	lb.	..	..
Rutile (TiO_2) powdered, 95%	lb.	.15-.20	.20-.25
Salt cake, glassmakers (Na_2SO_4)	ton	22.00	..
Selenium (Se)	lb.	..	1.90-2.00
Silver nitrate (AgNO.)	(100 oz.) per oz.	..	.36½
Soda ash (Na_2CO_3) dense, 58%—			
Bulk, on contract	Flat per 100 lb.	1.22½	..
In barrels	Per 100 lb.	1.55-1.57½	1.80
In bags	Per 100 lb.	1.37½-1.40	1.62½
Spot orders .025 per 100 lbs. higher			
Sodium bichromate ($Na_2Cr_2O_7$)	lb.	.07	.07½
Sodium hydrate (NaOH) (caustic soda) Solid	Per 100 lb.	2.90	..
Sodium nitrate ($NaNO_3$)—			
Refined (gran.) in bbls.	lb.	.03⅞	.04½
95 per cent.	Per 100 lb.	2.10	2.30
Sodium selenite (Na_2SeO_3)	lb.	..	2.35
Sodium fluosilicate (Na_2SiF_6)	lb.	.05	.05½
Sodium uranate (Na_2UO_4) Yellow or Orange	lb.	..	1.50
Sulphur (S)—			
Flowers, in bbls.	Per 100 lb.	3.45	3.80-4.00
Flowers, in bags	Per 100 lb.	3.10	3.45-3.65
Flour, heavy in bbls.	Per 100 lb.	2.85	3.20-3.40
Tin chloride ($SnCl_2$) (crystals)	lb.	.39	.37½
Tin oxide (SnO_2) in bbls.	lb.	..	.49
Uranium oxide (UO_2) (black, 96% U_3O_8) 100 lb. lots	lb.	..	1.50-2.00
Zinc oxide (ZnO)	lb.	.08½	.12
American process. Bags	lb.	.06½	.07
Zircon			
Granular (Milled .005-.02c higher)		.07	.07½-.08
Crude. Gran. (Milled .005-.02c higher)		.03½	.04-.05

Monthly Summary of United States Foreign Commerce in Glass

EXPORTS

Corrected to August 23, 1929

	July 1928 Quantity	July 1928 Value	July 1929 Quantity	July 1929 Value	Seven Months Ending July, 1928 Quantity	Seven Months Ending July, 1928 Value	Seven Months Ending July, 1929 Quantity	Seven Months Ending July, 1929 Value
Glass and glass products (total)	.....	$1,017,385	.....	$995,090	.....	$5,789,295	.....	$6,493,447
Plate and window glass—								
Window glass, common, box 50 sq. ft.	1,094	10,760	730	7,462	10,160	62,098	11,316	65,270
Plate glass, unsilvered, sq. ft.	207,203	62,134	100,318	38,945	1,322,346	401,741	1,259,544	444,706
Other window and plate glass lbs.	171,298	16,616	408,202	47,784	1,803,220	207,544	2,672,759	288,363
Glass containers (bottles, vials and jars)	.....	429,523	.....	402,040	.....	2,134,909	.....	2,141,226
Table glassware, plain	.....	125,974	.....	113,238	.....	773,894	.....	876,914
Table and other glassware, cut or engraved	.....	34,967	.....	7,676	.....	91,037	.....	69,304
Lamp chimneys and lantern globes lbs.	111,460	25,867	213,063	40,281	1,079,072	214,626	987,451	200,737
Globes and shades for lighting fixtures lbs.	150,486	54,236	180,986	62,936	960,421	357,889	1,232,809	448,619
Chemical glassware lbs.	21,570	21,577	24,618	22,022	122,506	110,502	143,519	129,900
Electrical glassware, except for lighting lbs.	389,400	31,379	244,408	25,888	2,864,150	230,171	3,711,500	290,463
Other glassware	.....	204,352	.....	226,818	.....	1,204,884	.....	1,537,945

IMPORTS

Corrected to August 23, 1929

Glass and glass products	.....	1,313,395	.....	1,361,945	.....	8,075,466	.....	8,067,686
Cylinder, crown and sheet—								
Unpolished, not bent, obscured, beveled, etc.—								
Weighing less than 80 pounds per case dut. lb.	1,995,290	49,933	2,945,479	75,200	19,643,460	556,119	26,496,038	694,258
Weighing 80 pounds or over per case dut. lb.	2,047,921	105,784	1,576,181	45,988	19,707,734	876,073	21,954,363	821,955
Polished and bent, obscured, beveled, colored, etc., unpolished and polished, and all silvered dut.	.....	54,217	.....	24,319	.....	311,249	.....	355,196
Plate glass—								
Polished, unsilvered dut. sq. ft.	1,106,762	226,831	940,695	188,834	8,933,483	1,945,306	6,250,194	1,330,146
Other dut. sq. ft.	218,835	62,643	138,103	27,345	947,062	241,642	871,643	164,657
Bottles, vials, jars, demijohns and carboys, molded or pressed dut.	.....	23,574	.....	25,359	.....	126,664	.....	149,391
Table and kitchen utensils dut.	.....	22,873	.....	33,381	.....	155,328	.....	164,051
Glassware, cut or decorated dut.	.....	237,137	.....	311,720	.....	1,432,932	.....	1,734,215
Blown glassware, n. e. s.—								
Bottles, ornaments, gauge glasses and other n. e. s. dut.	.....	279,485	.....	321,535	.....	744,416	.....	836,757
Bulbs for electric lamps dut. No. 1	1,314,499	14,860	845,459	8,201	7,778,351	80,946	9,505,275	81,612
Chimneys, globes, shades, prisms and other illuminating glassware dut.	.....	80,106	.....	68,540	.....	512,023	.....	519,328
Articles and utensils for chemical, scientific, and experimental purposes dut.	.....	49,468	.....	78,132	.....	316,181	.....	373,856
Other glassware dut.	.....	106,484	.....	153,391	.....	776,587	.....	842,264